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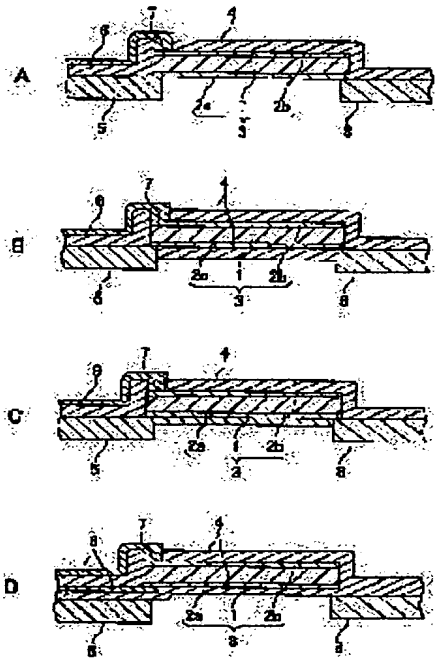
## (54) ACTUATOR AND RECORDED INFORMATION REPRODUCTION DEVICE AND MANUFACTURING METHOD OF ACTUATOR

(57)Abstract:
PROBLEM TO BE SOLVED: To adjust a resonance frequency of a piezoelectric material for an actuator made of a thin film improving its rigidity by reinforcing it by a shape retaining board made of a synthetic resin.
SOLUTION: The actuator is provided with a shape retaining board (4), a piezoelectric material (1) which is disposed on the shape retaining board making a single body with it, and a pair of electrodes (2a, 2b) which are formed catching the piezoelectric material between them. A synthetic resin is used for the shape retaining board. A piezoelectric element can be made of elements without using an adhesive, and make its elements micro-fine and a design freely. The actuator brings about a remarkably better displacement. Especially when it is used for an actuator of a magnetic head or the like, it makes a highly accurate controllable actuator and a recorded information reproduction device.

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3.In the drawings, any words are not translated.

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CLAIMS

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[Claim(s)]
[Claim 1] The actuator characterized by being the actuator equipped with the configuration maintenance board, the piezo-electric member arranged by unifying on the aforementioned configuration maintenance board, and the electrode of the couple formed so that the aforementioned piezo-electric member might be put, and the aforementioned configuration maintenance board being synthetic resin.
[Claim 2] a piezo-electric member -- the thin film of the range of 1.0-5.0-micrometer thickness -- forming -- the aforementioned piezo-electricity -- the actuator according to claim 1 made to drive using the deflection of the thickness direction of a member
[Claim 3] The actuator according to claim 1 which is the photoresist of the range whose synthetic resin is the thickness of 1.0-10.0 micrometers.
[Claim 4] The actuator according to claim 1 whose synthetic resin is at least one resin chosen from the positive-type photopolymer and the poly BENZO oxazole resin containing polyimide resin.
[Claim 5] The actuator according to claim 1 using synthetic resin as an electric insulation layer.
[Claim 6] The actuator according to claim 1 whose synthetic resin is the electric insulation layer of the signal line which sends the drive wire or signal used for the drive of an actuator.
[Claim 7] The actuator according to claim 1 which has and pulls out or more at least one flection to the field which forms an actuator for the aforementioned bitter taste tutor's drive wire.
[Claim 8] The actuator according to claim 7 from which a part of substrate [ at least ] in which the aforementioned drive wire is formed is removed by etching.
[Claim 9] The aforementioned drive wire is an actuator according to claim 7 which consists of the synthetic resin of an electric insulation layer, copper, and synthetic resin of a cover layer at least.
[Claim 10] The aforementioned drive wire is an actuator according to claim 7 with which a principal component is formed with copper and synthetic resin is covered as an electric insulation layer in the front face.
[Claim 11] For a copper drive wire, a principal component is the actuator according to claim 10 with which it is formed of plating.
[Claim 12] It is the actuator according to claim 1 which equips the bottom of synthetic resin with a substrate further, and is used as a protective layer from which the aforementioned synthetic resin protects a configuration maintenance board and a piezo-electric member.
[Claim 13] The actuator according to claim 1 which added reinforcing materials in order to raise mechanical intensity to synthetic resin.
[Claim 14] the unification with a configuration maintenance board and a piezo-electric member -- piezo-electricity -- the actuator according to claim 1 which is unification apply the resin which serves as a configuration maintenance board on the surface of a member, and according to baking
[Claim 15] A configuration maintenance board and the piezo-electric member arranged by unifying on the aforementioned configuration maintenance board, The slider in which is equipped with the electrode of the couple formed so that the aforementioned piezo-electric member might

be put, and a head is further carried using the actuator whose aforementioned configuration maintenance board is synthetic resin, It has the tracking means by the head which carries out tracking through the head support mechanism which supports a head through the aforementioned slider, and the aforementioned head support mechanism. The information record regenerative apparatus characterized by carrying out the variation rate of the aforementioned head minutely by equipping the aforementioned head support mechanism with the aforementioned actuator, and driving this actuator.

[Claim 16] The driving direction of an actuator is a mainly parallel information record regenerative apparatus according to claim 15 to a disk side.

[Claim 17] The manufacture method of an actuator which is equipped with the following, is the manufacture method of an actuator that the aforementioned configuration maintenance board is synthetic resin, forms a lower electrode by thin film processing to the substrate which processed the actuator configuration, forms a piezo-electric thin film, forms an up electrode, and is characterized by forming the configuration maintenance board which next consists of synthetic resin. Configuration maintenance board. the piezo-electricity arranged by unifying on the aforementioned configuration maintenance board -- a member The electrode of the couple formed so that the aforementioned piezo-electric member might be put.

[Claim 18] The manufacture method of the actuator according to claim 17 which replaced a part of base material [ at least ] which forms the aforementioned actuator by synthetic resin.

[Claim 19] The manufacture method of the actuator according to claim 17 which forms membranes directly to a substrate at the time of membrane formation of a piezo-electric thin film.

[Claim 20] The manufacture method of the actuator according to claim 17 which applies synthetic resin by at least one method chosen as a substrate from the spinner method, the rolling method, and dip coating.

[Claim 21] The manufacture method of the actuator according to claim 17 which carries out unification formation of baking, a configuration maintenance board, and the piezo-electric member after applying synthetic resin.

[Claim 22] The manufacture method of the actuator according to claim 17 which makes thickness of a substrate thin by etching, or is removed on a partial target after applying synthetic resin.

[Claim 23] The manufacture method of the actuator according to claim 17 which **********s a substrate by using synthetic resin as an etching pattern.

[Claim 24] The manufacture method of an actuator which it has the following, is the manufacture method of an actuator that the aforementioned configuration maintenance board is synthetic resin, forms a lower electrode by thin film processing to a substrate, processes a substrate, a lower electrode, a piezo-electric thin film, and an up electrode into an actuator configuration, and is characterized by forming the configuration maintenance board which next consists of synthetic resin after forming a piezo-electric thin film after that and forming an up electrode further. Configuration maintenance board. the piezo-electricity arranged by unifying on the aforementioned configuration maintenance board -- a member The electrode of the couple formed so that the aforementioned piezo-electric member might be put.

[Claim 25] The manufacture method of the actuator according to claim 24 which replaced a part of base material [ at least ] which forms the aforementioned actuator by synthetic resin.

[Claim 26] The manufacture method of the actuator according to claim 24 which forms membranes directly to a substrate at the time of membrane formation of a piezo-electric thin film.

[Claim 27] The manufacture method of the actuator according to claim 24 which applies synthetic resin by at least one method chosen as a substrate from the spinner method, the rolling method, and dip coating.

[Claim 28] The manufacture method of the actuator according to claim 24 which carries out unification formation of baking, a configuration maintenance board, and the piezo-electric member after applying synthetic resin.

[Claim 29] or [ making thickness of a substrate thin by etching, after applying synthetic resin ] -

- or the manufacture method of the actuator according to claim 24 to remove
[Claim 30] The manufacture method of the actuator according to claim 24 which **********s a substrate by using synthetic resin as an etching pattern.
[Claim 31] The manufacture method of an actuator which is the actuator whose aforementioned configuration maintenance board is synthetic resin, is equipped with the following, processes an actuator configuration using lithography technology after forming a lower electrode, a piezo-electric thin film, and an up electrode to a substrate, and is characterized by to imprint the aforementioned lower electrode, a piezo-electric thin film, and an up electrode to the pattern formed by synthetic resin. Configuration maintenance board. the piezo-electricity arranged by unifying on the aforementioned configuration maintenance board -- a member The electrode of the couple formed so that the aforementioned piezo-electric member might be put.
[Claim 32] The manufacture method of the actuator according to claim 31 which forms membranes directly to a substrate at the time of membrane formation of a piezo-electric thin film.
[Claim 33] The manufacture method of the actuator according to claim 31 which applies synthetic resin by at least one method chosen as a substrate from the spinner method, the rolling method, and dip coating.
[Claim 34] The manufacture method of the actuator according to claim 31 which carries out unification formation of baking, a configuration maintenance board, and the piezo-electric member after applying synthetic resin.
[Claim 35] or [ making thickness of a substrate thin by etching, after applying synthetic resin ] -- or the manufacture method of the actuator according to claim 31 to remove
[Claim 36] The manufacture method of the actuator according to claim 31 which **********s a substrate by using synthetic resin as an etching pattern.

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[Translation done.]

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the information record regenerative apparatus using the actuator used for various electronic parts etc., its manufacture method, and the actuator.
[0002]
[Description of the Prior Art] The micro valve of a stopped type usually shown in the "trial production of micropump for integration chemical-analysis systems" electronic-intelligence communication society paper magazine (C, vol.J71-C, No.12 (1988), pp.1705-1711) by Shoji and others as a device (piezo-electric micro-actuator) using the piezoelectric device and a micropump are raised. Moreover, as an application of a longitudinal-effect form electrostrictive actuator, there are positioning of the diamond edge of a blade of a precision lathe, a drive of the needle of a scanning tunneling microscope, etc. Thus, by miniaturizing a piezoelectric device more and having advanced features, the use to a micro machine, a micro sensor, etc. is considered, and the bird clapper is expected that minute and precise control is possible in various fields made impossible so far.
[0003] On the other hand, in the actuator for HDD, what the magnetic head is doubled with the truck of a medium for (it positions) is becoming difficult by reduction in the width of recording track in connection with the densification of HDD (hard disk drive).
[0004] In the conventional magnetic disk unit, the seeking drive of the magnetic head was performed using voice coil motor (VCM) or rotary type VCM.
[0005] Based on such a background, in order to raise positioning accuracy, in HDD (hard disk drive), there is an inclination of use of an actuator of a two-step formula which is used in optical disk relation (CD, MO, DVD, etc.) recently.
[0006] Generally as a method of the actuator of a two-step formula, an electrostatic method, a piezo-electric method, a magnetostriction method, etc. are raised.
[0007] An example of such a two-step formula actuator is proposed by JP,9-265738,A. This is shown in drawing 24 . The structure where the head support mechanism (suspension 25) in which a head slider (with no illustration) is fixed as shown in this drawing vibrates to the flutter actuator (with no illustration) of a magnetic disk unit is indicated. Its attention is paid to improvement in the track density of a magnetic disk unit by this proposal. On both sides of the center of rotation of the head mount block (mounting section 22) which is a fixed part with the flutter actuator of the head support mechanism (suspension 25) in which the head slider is being fixed in drawing 24 , the planar type piezo-electric element 23 of a couple is incorporated. A head support mechanism (suspension 25) is made to rock minutely, and it enables it to carry out the minute variation rate of the head slider and head element which were fixed at the nose of cam of a head support mechanism by carrying out differential of them. Although the planar type piezo-electric element 23 cannot generate a big variation rate, it has expanded the variation rate of the planar type piezo-electric element 23 by 8 times in the head element position by carrying out minute rotation of the suspension 25 focusing on a hinge. By this proposal, by interlocking and performing minute positioning of the head slider by minute rocking of positioning of a flutter

actuator and a head support mechanism, and a head element, the positioning accuracy of the direction of the width of recording track of a head element improves, and it is indicated that track density can be made high. moreover, assembly **** after, as for this positioning mechanism, a suspension 25, the mounting section 22, and the planar type piezo-electric element 23 were formed separately -- things can guess easily from drawing 24
[0008] As above, generally the piezoelectric device of the conventional technology had small generating displacement / element size, and had the problem to which a variation rate will be restrained by structure and displacement/voltage (efficiency) becomes small according to it. Moreover, in the manufacture process which needs micro processing, such as an element using the piezo-electric thin film, it was difficult to use micro processing, adhesives, etc.
[0009]
[Problem(s) to be Solved by the Invention] this invention aims at offering the manufacture method of an improvement of element efficiency, the actuator which improved the process tolerance, an information record regenerative apparatus, and an actuator using the structure of using synthetic resin as a charge of a configuration maintenance plate, in order to solve the aforementioned conventional problem.
[0010]
[Means for Solving the Problem] In order to attain the aforementioned purpose, the actuator of this invention is an actuator equipped with the configuration maintenance board, the piezo-electric member arranged by unifying on the aforementioned configuration maintenance board, and the electrode of the couple formed so that the aforementioned piezo-electric member might be put, and is characterized by the aforementioned configuration maintenance board being synthetic resin.
[0011] Next, the piezo-electric member arranged by unifying the information record regenerative apparatus of this invention on a configuration maintenance board and the aforementioned configuration maintenance board, The slider in which is equipped with the electrode of the couple formed so that the aforementioned piezo-electric member might be put, and a head is further carried using the actuator whose aforementioned configuration maintenance board is synthetic resin, It has the tracking means which carries out the tracking of the head through the head support mechanism which supports a head through the aforementioned slider, and the aforementioned head support mechanism. It is characterized by carrying out the variation rate of the aforementioned head minutely by equipping the aforementioned head support mechanism with the aforementioned actuator, and driving this actuator.
[0012] Next, the 1st manufacture method of the actuator of this invention A configuration maintenance board and the piezo-electric member arranged by unifying on the aforementioned configuration maintenance board, It is the manufacture method of an actuator that it has the electrode of the couple formed so that the aforementioned piezo-electric member might be put, and the aforementioned configuration maintenance board is synthetic resin. It is characterized by forming a lower electrode by thin film processing to the substrate which processed the actuator configuration, forming a piezo-electric thin film, forming an up electrode, and forming the configuration maintenance board which next consists of synthetic resin.
[0013] Next, the 2nd manufacture method of the actuator of this invention A configuration maintenance board and the piezo-electric member arranged by unifying on the aforementioned configuration maintenance board, It is the manufacture method of an actuator that it has the electrode of the couple formed so that the aforementioned piezo-electric member might be put, and the aforementioned configuration maintenance board is synthetic resin. A lower electrode is formed by thin film processing to a substrate, after forming a piezo-electric thin film after that and forming an up electrode further, a substrate, a lower electrode, a piezo-electric thin film, and an up electrode are processed into an actuator configuration, and it is characterized by forming the configuration maintenance board which next consists of synthetic resin.
[0014] Next, the 3rd manufacture method of the actuator of this invention A configuration maintenance board and the piezo-electric member arranged by unifying on the aforementioned configuration maintenance board, It is the manufacture method of an actuator that it has the electrode of the couple formed so that the aforementioned piezo-electric member might be put,

and the aforementioned configuration maintenance board is synthetic resin. After forming the aforementioned lower electrode, a piezo-electric thin film, and an up electrode to a substrate, an actuator configuration is processed using lithography technology and it is characterized by imprinting the aforementioned lower electrode, a piezo-electric thin film, and an up electrode to the pattern formed by synthetic resin.
[0015] According to this invention, a piezoelectric device can be element-ized, without using adhesives, and detailed-izing of an element and a free design are still more possible. moreover, as compared with the conventional piezoelectric device, it can be markedly alike, and a variation rate can be obtained When it applies as actuators, such as the magnetic head, especially, a controllable actuator and a controllable information record regenerative apparatus can be realized with high precision. Moreover, although a miniaturization is needed when [ that resonance frequency is low ] high-speed control is difficult, even if it miniaturizes, displacement/voltage (efficiency) can be taken out efficiently. Moreover, it is possible to also lower power consumption by thin-film-izing.
[0016]
[Embodiments of the Invention] The piezo-electric thin film formula actuator of this invention and an actuator mechanism, and an information record regenerative apparatus perform a problem solving using the following meanses. First, the simple composition of an actuator mechanism consists of a bridging required in order to function as the electrode of the couple formed so that a piezo-electric thin film and a piezo-electric thin film might be put, the configuration maintenance board which supports a thin film, and a device.
[0017] The plastic material which consists of synthetic resin is especially used for configuration maintenance Itabe. Since configuration maintenance Itabe of a piezo-electric thin film is made to flexible structure by using this composition, it becomes possible to also enlarge the variation rate of parenchyma. the electrode and configuration maintenance in which the mechanical strength was formed as a device so that a piezo-electric thin film might be put between a low case -- a thin metal membrane and an oxide film are inserted as reinforcing materials on the outside (field opposite to a piezo-electric thin film) of a wooden floor or a configuration maintenance board, or the electrode of a field opposite to a configuration maintenance board Or thickness of the synthetic resin which constitutes configuration maintenance Itabe is thickened. Or it forms so that a piezoelectric device may be wrapped in synthetic resin from both sides.
[0018] Furthermore, when a mechanical strength is insufficient, the portion to which intensity is insufficient for the mechanical component which is a piezoelectric device using other parts is reinforced. Thus, the role portion which operates as an actuator, and the role portion which raises a mechanical strength are formed separately, and is combined.
[0019] An electrode and an electrode outgoing line vacate and take out a through hole to the synthetic resin which constitutes a configuration maintenance board. It is possible to use the deflection of the thickness direction of a piezo-electric thin film as driving means by such composition.
[0020] Moreover, these can realize very detailed structure, in order to produce using lithography technology, and they become possible [ treating synthetic resin independently as one element by accompanying ]. Therefore, it is possible to produce complicated structure, for example, the piezoelectric device of all the composition of-dimensional [ 2 ] and the three-dimensional structure can be realized only by combining single elements, such as bimorph structure, and a laminated structure, drive composite construction. If a piezoelectric device is fixed to a bridging, it will function as an actuator.
[0021] Although it is a means the piezoelectric device of the above composition produces the piezoelectric device of the simplest composition, and realize various composition combining them, when producing the element section using lithography technology, it is also possible to really form the piezoelectric device which employed composition of the above-mentioned structure or each single element in the drive efficiently by accompanying synthetic resin combining the two or more element sections.
[0022] Next, the solution means about the actuator mechanism in the case of applying to actuators, such as a hard disk drive, is explained.

[0023] About the problem that there is the need of raising positioning accuracy, the structure of carrying out the rotation drive of the slider which holds a head element according to a displacement reduction mechanism by making into a driving source the actuator with which big movement is obtained (a stroke can be earned) is taken. In the above, the actuator from which big movement is obtained shows the actuator of the structure which accompanies the synthetic resin described above.
[0024] It arranges so that it may become symmetrical with a field in the field which met the position which specifically hits in the suspension of a head support mechanism, and the middle of the slider section to the disk side at the center line of the longitudinal direction of a perpendicular and a suspension in at least two driver elements which constitute an actuator.
[0025] Rotation of a disk surfaces the dozens of nm slider section by the wind pressure. The more the rotational speed of a disk becomes quick at this time, the more the air viscous-friction force (frictional force produced according to the phenomenon in which a slider is pulled by the hand of cut of a disk) of Number mN (milli newton) arises about between a slider and a disk. If a slider is pulled by the hand of cut of a disk according to the viscous-friction force, while also in the suspension which has the driver element of subminute driving means rigidity will be pulled by the hand of cut of a disk at a low case and the flying height of a slider will become unstable, subminute driving means will also become uncontrollable. Then, each driver element is arranged from the point of the rigidity of a suspension, and the controllability of subminute driving means at the angle from which the field which met the center line of the longitudinal direction of a perpendicular and a suspension to the disk, and the angle to accomplish turn into 15 degrees or more. By carrying out the seal of approval of the voltage of an opposite phase to the driver element of the both, and operating it, the head support mechanism in which the slider was attached can be rotated, the slider which the head element consisted of can be rotated in parallel to a disk side, and highly precise positioning is attained. Since such composition constitutes the configuration maintenance board of the driver-element section from a flexible material, the mechanical strength of a direction perpendicular to the direction of a deflection and disk side of a piezoelectric device becomes low.
[0026] the electrode formed so that the mechanical strength of the piezoelectric-device section might put a piezo-electric thin film between a low case, as stated above, and configuration maintenance -- a thin metal membrane, an oxide film, etc. are inserted as reinforcing materials on the outside (field opposite to a piezo-electric thin film) of a wooden floor and a configuration maintenance board, or the electrode of a field opposite to a configuration maintenance board Or thickness of the synthetic resin which constitutes configuration maintenance Itabe is thickened. Or it forms so that a piezoelectric device may be wrapped in synthetic resin from both sides.
[0027] Furthermore, when a mechanical strength is insufficient, the portion to which intensity is insufficient for the mechanical component which is a piezoelectric device using other parts is reinforced. Thus, drive displacement can be enlarged, without reducing a mechanical strength by constituting separately the role portion which operates as an actuator, and the role portion which raises a mechanical strength, and combining it.
[0028] As another structure of an actuator mechanism, at least two driver elements (piezoelectric device) which constitute an actuator are arranged in parallel to a disk side in the position which hits in the suspension of a head support mechanism, and the middle of the slider section. By taking the structure like a doubly-supported beam structurally, and preparing one pore A fixed part, moving part, and at least two beam sections that connect these are formed in one. At least, prepare an electrode layer (not shown) and the displacement generating section is constituted so that expansion and contraction (bending of the thickness direction) at the direction of at least one beam section which connects a fixed part and moving part in part may arise. a variation rate -- the arc [ variation rate / of the moving part to the fixed part generated with expansion and contraction (deflection of the thickness direction) of the generating section ] within the field of a plate -- a variation rate or rotation -- it constitutes so that it may become a variation rate Especially, the configuration maintenance board of the piezoelectric device for a mechanical component is produced using synthetic resin at least, flexibility is given very much, and a big variation rate is obtained. It is arranged in the position which specifically hits in the

suspension of a head support mechanism, and the middle of the slider section, and one of the two's fixed part is fixed to a suspension, and one of the two is already fixed to the slider section.

[0029] In the case of this structure, in order to take the structure which a vertical (the gravity direction) mechanical strength is low, and supports a slider with an actuator further especially to a disk side about the piezoelectric-device section, the remarkable demand of the mechanical strength of this direction is carried out. the electrode formed so that the mechanical strength of the piezoelectric-device section might put a piezo-electric thin film between a low case, as stated above, and configuration maintenance -- a thin metal membrane and an oxide film are inserted as a reinforcing agent on the outside (field opposite to a piezo-electric thin film) of a wooden floor or a configuration maintenance board, or the electrode of a field opposite to a configuration maintenance board Or thickness of the synthetic resin which constitutes configuration maintenance Itabe is thickened. Or it forms so that a piezoelectric device may be wrapped in synthetic resin from both sides.
[0030] Furthermore, when a mechanical strength is insufficient, the portion to which intensity is insufficient for the mechanical component which is a piezoelectric device using other parts is reinforced. Thus, the role portion which operates as an actuator, and the role portion which raises a mechanical strength are constituted separately, and is combined.
[0031] it having been possible to have produced a laminated structure, drive composite construction, etc. by combining the actuator of such structure, when the torque at the time of a drive is insufficient, and having used-dimensional [ 2 ] and the three-dimensional structure -- the piezo-electric thin film actuator of all composition is realizable
[0032] Moreover, the mechanical design of an actuator mechanism is possible, without being caught not much by the interrelation of a mechanical strength and a variation rate in this way.
[0033] Next, a means to solve the fault to which a variation rate will be restrained in connection with structure, and displacement/voltage (efficiency) becomes small is explained.
[0034] The variation rate which a driver element generates can be efficiently told to the slider possessing a head element by making it composition in which the driving direction of the driver element of the actuator section and the displacement direction of the slider section in which the head element is formed become almost parallel. general -- a drive -- a variation rate and rigidity (mechanical strength) -- the relation of inverse proportion -- it is -- a drive -- if it is going to enlarge a variation rate, and rigidity must be reduced and rigidity will be raised conversely -- a drive -- a variation rate is reduced the rigidity which can bear an inertia force in case the member to which this first cause supports a slider against gravity, the rigid member which can bear the viscous-friction force of receiving from a disk, and the main mechanical component result [ from a drive ] in a halt -- since members, such as a member, and the member of the mechanical component which generates a variation rate are constituted from same member, it is generated Therefore, it becomes possible to combine with other rigid members by considering as the device which can treat the piezoelectric-device section independently, and even if rigidity is high, an actuator with big drive displacement is realizable.
[0035] Since it becomes structure with the very flexible piezoelectric-device section by using synthetic resin for the configuration maintenance board of the piezoelectric-device section at least especially, it becomes possible for this portion to absorb loss by the restraint at the time of a drive, and to make a displacement fall into the minimum.
[0036] Since sufficient displacement/voltage are obtained by using the above-mentioned structure even if a driver element is small compared with the conventional example of drawing 24 , the problem with difficult high-speed control that resonance frequency is low can also set up resonance frequency highly, and the high-speed highly precise control of it is attained.
[0037] Furthermore, it becomes possible to suppress resonance by coating places other than configuration maintenance Itabe with synthetic resin.
[0038] About the problem to which driver voltage affects power consumption and a head element greatly, since displacement/voltage sufficient by thin-film-izing piezoelectric material (about 1micrometer/**3-5V) are obtained using the above-mentioned structure, even if compared with the conventional example, a low power is possible, and influence which it has on a head element

can also be lessened.
[0039] Since a thin film is moreover used, it is possible to use a thin film process and lithography technology, and package production also of an electrode and wiring is attained according to this process.
[0040] About the wiring for driving a piezoelectric device, as soon as it processes the piezo-electric thin film of the element section using lithography technology, it forms. Synthetic resin is applied after processing a piezo-electric thin film into a predetermined configuration, and patterning is carried out in order to use as the configuration maintenance board of an element, a protective layer, and an insulating layer. After BEKU and stiffening synthetic resin, the resist for plating is applied and patternized. A conductor is plated using the pattern and wiring is formed. After carrying out resist removal for plating, the synthetic resin for covering is applied, patternized and stiffened. Even if it removes the substrate in which the piezoelectric device is formed from a piezoelectric device by using structure which puts wiring by such synthetic resin, and the structure which makes synthetic resin protection and the base material of a piezoelectric device, a configuration is maintained because synthetic resin replaces as a configuration maintenance board, protection material, or a base material of a piezo-electric thin film (piezoelectric device). Moreover, since wiring is also formed simultaneously, it can treat as a driver-element simple substance, and operation by the element independent is possible, and it is also possible to use it with adhesives etc., pasting other members etc.
[0041] Moreover, flexible wiring structure becomes possible by making a wiring portion into the structure of synthetic resin / conductor (wiring material) / synthetic resin at least. It is possible to take out wiring, even if it is not on the same field which forms a piezoelectric device according to this structure.
[0042] Furthermore, when the pasted-up member when the substrate in which the piezoelectric device was formed is flexible like metals, such as stainless steel, has a flexible property, it is possible to take out wiring also in a three-dimensions-spacial configuration by bending the whole substrate.
[0043] Next, a manufacturing method is explained. The substrate used since the production process changes with processing states of the substrate used for producing a piezo-electric thin film as a manufacturing method explains below.
[0044] (Processing substrate) When the substrate is beforehand processed into the actuator configuration, production of a piezo-electric thin film forms membranes to a direct substrate using a spatter etc. As film composition, it becomes a lower electrode, a piezo-electric thin film, and an up electrode (this composition is called piezoelectric device below). In this case, processing of the formed piezo-electric thin film and a lower electrode, and an up electrode may use and patternize a metal mask etc. at the time of membrane formation, or may process it by dry etching or wet etching after membrane formation using lithography technology.
[0045] Formation of wiring is performed after element processing. When a substrate is the conductive matter, since the lower electrode is in contact with the substrate, it takes out an electrode through a substrate. On the other hand, an up electrode applies the synthetic resin of the base used as an insulating layer, and it patternizes and it is made to harden it so that it may become the configuration which takes out wiring. In order to take the up electrode of a piezoelectric device, and a flow, the through hole is formed in a part of up electrode at the synthetic resin of the base. On the synthetic resin of the base which is an insulating layer, the spatter of seed layer Cr/Cu for copper coating is carried out, and the pattern for copper coating is formed using a resist after that. Using this pattern, with electrolysis plating, about 2-10 micrometers of copper coating are formed, and the synthetic resin for covering is applied, patternized and stiffened after removing the resist for plating.
[0046] When a substrate is not the conductive matter, in case a piezo-electric thin film and an up electrode are processed, it is made the composition which removed partially the piezo-electric thin film on a lower electrode, and up electrode section, and is made the composition which takes out a lower electrode from the portion from which the up electrode and the piezo-electric thin film were removed. Synthetic resin is applied and stiffened [ patternize and ] on an element. The through hole for taking out a lower electrode and an up electrode at this time is

formed simultaneously. On the synthetic resin of the base which is an insulating layer, the spatter of seed layer Cr/Cu for copper coating is carried out, and the pattern for copper coating is formed using a resist after that. Using this pattern, with electrolysis plating, about 2-10 micrometers of copper coating are formed, and the synthetic resin for covering is applied, patternized and stiffened after removing the resist for plating.
[0047] Next, a substrate is processed. Processing of a substrate is divided into partial processing which processes the configuration maintenance board portion of the piezoelectric-device section, and all processings that process all substrates. In partial processing, except for near configuration maintenance Itabe of the field which processes it, the double spread of the synthetic resin for processing is carried out using the spinner method (spin coater), the rolling method, dip coating, a spray method, the ink-jet method, etc. It is desirable to use properly by the case as the method of application, for example, to use dip coating or the rolling method, when control of thickness is not not much required, and to use the spinner method (spin coater) or a spray method, when control of thickness is required. Moreover, when applying application material efficiently, or when you want to apply partially, it is desirable to use the ink-jet method.
[0048] As a method of removing synthetic resin partially in order to patternize synthetic resin to substrate processing, in the case of photosensitive synthetic resin, pattern technology, such as exposure and development, may be used, or only the portion may remove synthetic resin using laser processing, for example. What method may be used as long as it is the way the synthetic resin of the portion to process is removable.
[0049] Then, the portion which is not coated with the synthetic resin of a substrate using wet etching is processed.
[0050] There is a method of removing all of half etching which leaves and processes only thickness with a substrate as the processing method, and a substrate. This may choose whichever with the rigidity and the variation rate which are needed.
[0051] Next, how to ********** and remove not partial etching but all substrates is explained. First, synthetic resin is applied to the substrate side where the piezoelectric device is formed. The process so far is the same as the process at the time of the above-mentioned partial processing. All substrates are removed by etching after that. In removing all substrates, Pt layer of a lower electrode serves as a stopper of etching to an etching reagent. By this, a piezoelectric device becomes the form imprinted by the synthetic-resin layer formed by synthetic resin from a substrate. Adhesion of synthetic resin is comparatively good, and the imprint of a piezoelectric device of it is attained easily, without using adhesives, if such a method of construction is used. If the wiring simultaneously explained above at this time is formed, the ejection of wiring will become it is very easy and possible [ dealing with it as an element simple substance ]. Moreover, wiring ejection to a different field from a piezo-electric thin film forming face and formation of a-like 3-dimensional spacial configuration etc. are enabled.
[0052] Although the manufacture method was described briefly above, the most important point is a wrap thing in synthetic resin, as the piezoelectric-device sections including the side of a piezoelectric device do not receive a damage, when **********ing a substrate. Usually, since thickness is thick compared with a piezo-electric thin film, generally as for the substrate which forms a piezo-electric thin film, wet etching is used. Since the etching reagent of strong acid nature and strong-base nature is used as an etching reagent, in order to ********** to a piezo-electric thin film, there is wrap need using synthetic resin. Before substrate etching, beforehand, patterning of the lithography technology is used and carried out, and the electrode for a piezoelectric-device drive and wiring form it. At this time, synthetic resin is used also as an insulating layer and enables one formation of drive wiring. Although the manufacturing method at the time of using a processing substrate simply above was explained, the general place of a pattern configuration is decided by the configuration of a processing substrate in this case.
[0053] Wiring vacates a through hole for a part of lower part and up electrode, when applying and carrying out patterning of the synthetic resin to a piezoelectric device, it takes out an electrode using the through hole, and forms the wiring section. As the electrode formation method, it is a spatter, vacuum evaporationo, etc., after forming electrode materials, such as Pt and Au, a circuit pattern configuration may be processed, or you may form with plating etc.

[0054] When the rigidity of the element section is insufficient, a metal membrane, a several microns oxide film, etc. are beforehand formed as reinforcing materials at the time of piezoelectric-device membrane formation, or it forms with plating. Or you may thicken thickness of synthetic resin.
[0055] (Non-processed substrate) The manufacturing method in the case of using the substrate which is not beforehand processed into an actuator configuration is explained.
[0056] In using the substrate which is not processed, after processing the piezoelectric device after membrane formation, a substrate is processed into an actuator configuration and all of all or the manufacturing method which it leaves partially, and a substrate have the manufacturing method to remove in a substrate.
[0057] First, the case where all substrates are removed is explained. The piezoelectric-device section (a lower electrode / piezo-electric thin film / up electrode composition) is formed and processed into a substrate. Formation of wiring is performed after element processing. When a substrate is the conductive matter, since the lower electrode is in contact with the substrate, it takes out an electrode through a substrate. On the other hand, an up electrode applies the synthetic resin of the base used as an insulating layer, and it patternizes and it is made to harden it so that it may become the configuration which takes out wiring. In order to take the up electrode of a piezoelectric device, and a flow, the through hole is formed in a part of up electrode at the synthetic resin of the base. On the synthetic resin of the base which is an insulating layer, the spatter of seed layer Cr/Cu for copper coating is carried out, and the pattern for copper coating is formed using a resist after that. Using this pattern, with electrolysis plating, about 2-10 micrometers of copper coating are formed, and the synthetic resin for covering is applied, patternized and stiffened after removing the resist for plating.
[0058] When a substrate is not the conductive matter, in case a piezo-electric thin film and an up electrode are processed, it is made the composition which removed partially the piezo-electric thin film on a lower electrode, and up electrode section, and is made the composition which takes out a lower electrode from the portion from which the up electrode and the piezo-electric thin film were removed. Synthetic resin is applied and stiffened [ patternize and ] on an element. The through hole for taking out a lower electrode and an up electrode at this time is formed simultaneously. On the synthetic resin of the base which is an insulating layer, the spatter of seed layer Cr/Cu for copper coating is carried out, and the pattern for copper coating is formed using a resist after that. Using this pattern, with electrolysis plating, about 2-10 micrometers of copper coating are formed, and the synthetic resin for covering is applied, patternized and stiffened after removing the resist for plating.
[0059] Next, a substrate is processed. In removing all substrates, a piezoelectric device is formed on the surface of a substrate, and it carries out the single spread of the synthetic resin for processing using the spinner method (spin coater), the rolling method, dip coating, a spray method, the ink-jet method, etc. on it. As a method of removing partially the synthetic resin for patternizing synthetic resin to substrate processing, in the case of photosensitive synthetic resin, the pattern technology of lithography, such as exposure and development, may be used, or only the portion may remove synthetic resin using laser processing, for example. What method may be used as long as it is the way the synthetic resin of the portion to process is removable. Arrangement of a piezoelectric device can form an actuator configuration freely by using the manufacturing method using lithography technology at this time at the time of pattern configuration production of synthetic resin at the time of piezoelectric-device processing. Therefore, it becomes possible to produce a complicated configuration and various composition. If the wiring simultaneously explained above at this time is formed, the ejection of wiring will become it is very easy and possible [ dealing with it as an element simple substance ]. Moreover, wiring ejection to a different field from a piezo-electric thin film forming face and formation of a-like 3-dimensional spacial configuration etc. are enabled.
[0060] And all processings of the portion which is not coated with the synthetic resin of a substrate using wet etching etc., i.e., a substrate, are removed. In removing all substrates, Pt layer of a lower electrode serves as a stopper of etching to an etching reagent. By this, a piezoelectric device becomes the form imprinted by the synthetic-resin layer formed by

synthetic resin from a substrate. Adhesion of synthetic resin is comparatively good, and the imprint of a piezoelectric device of it is attained easily, without using adhesives, if such a method of construction is used. When the resin containing especially a polyimide is printed, adhesion with a diaphragm is good.
[0061] Although the manufacture method was described briefly above, the most important point is a wrap thing in synthetic resin, as the piezoelectric-device sections including the side of a piezoelectric device do not receive a damage, when **********ing a substrate. Usually, since thickness is thick compared with a piezo-electric thin film, generally as for the substrate which forms a piezo-electric thin film, wet etching is used. Since the etching reagent of strong acid nature and strong-base nature is used as an etching reagent, in order to ********** to a piezo-electric thin film, there is wrap need using synthetic resin. Before substrate etching, beforehand, patterning of the lithography technology is used and carried out, and the electrode for a piezoelectric-device drive and wiring form it. At this time, synthetic resin is used also as an insulating layer and enables one formation of drive wiring.
[0062] Next, the manufacturing method which leaves a substrate is explained.
[0063] There are two kinds of methods as a method of leaving a substrate. One is the method of leaving all as a pattern configuration, and another is the method of changing the thickness to leave.
[0064] As a method of leaving altogether as a pattern configuration, the piezoelectric-device section (a lower electrode / piezo-electric thin film / up electrode composition) is formed to a substrate, and a substrate is processed into it. Formation of wiring is performed after element processing. When a substrate is the conductive matter, since the lower electrode is in contact with the substrate, it takes out an electrode through a substrate. On the other hand, an up electrode applies the synthetic resin of the base used as an insulating layer, and it patternizes and it is made to harden it so that it may become the configuration which takes out wiring. In order to take the up electrode of a piezoelectric device, and a flow, the through hole is formed in a part of up electrode at the synthetic resin of the base. On the synthetic resin of the base which is an insulating layer, the spatter of seed layer Cr/Cu for copper coating is carried out, and the pattern for copper coating is formed using a resist after that. Using this pattern, with electrolysis plating, about 2-10 micrometers of copper coating are formed, and the synthetic resin for covering is applied, patternized and stiffened after removing the resist for plating.
[0065] When a substrate is not the conductive matter, in case a piezo-electric thin film and an up electrode are processed, it is made the composition which removed partially the piezo-electric thin film on a lower electrode, and up electrode section, and is made the composition which takes out a lower electrode from the portion from which the up electrode and the piezo-electric thin film were removed. Synthetic resin is applied, patternized and stiffened on an element. The through hole for taking out a lower electrode and an up electrode at this time is formed simultaneously. On the synthetic resin of the base which is an insulating layer, the spatter of seed layer Cr/Cu for copper coating is carried out, and the pattern for copper coating is formed using a resist after that. Using this pattern, with electrolysis plating, about 2-10 micrometers of copper coating are formed, and after removing the resist for plating, the synthetic resin for covering is made to apply and patternize, and is stiffened.
[0066] Next, a substrate is processed. The spinner method (spin coater), the rolling method, dip coating, a spray method, the ink-jet method, etc. are used, and the single spread of the synthetic resin is carried out to the field in which the piezoelectric device of a substrate is formed. As a method of removing partially the synthetic resin for patternizing synthetic resin to substrate processing, in the case of photosensitive synthetic resin, the pattern technology of lithography, such as exposure and development, may be used, or only the portion may remove synthetic resin using laser processing, for example. What method may be used as long as it is the way the synthetic resin of the portion to process is removable. And the portion which is not coated with the synthetic resin of a substrate using wet etching is processed. In this case, the field where synthetic resin is not applied since, as for synthetic resin, only one side is applied is stretched, and prevents from touching masking tape, a protection film, etc. directly at an etching reagent etc. Moreover, synthetic resin is applied also to a field high speed and opposite to a

piezoelectric-device forming face to carry out by being highly precise for etching of a substrate, a pattern is produced to both sides using a double-sided exposure machine etc., and etching is performed from both sides.
[0067] The method of the method of changing the thickness of a substrate by another method **********ing piezoelectric-device production, wiring formation, the method of applying synthetic resin, and a substrate is the same method of construction as the above. Next, the synthetic resin of the field in which the piezoelectric device is not formed is removed, and it etches by Mr. Atsushi of a wish using wet etching etc. again. Moreover, what is necessary is to form a pattern by synthetic resin again and just to etch a substrate to change thickness partially.
[0068] Although the manufacture method was described briefly above, the most important point is a wrap thing in synthetic resin, as the piezoelectric-device sections including the side of a piezoelectric device do not receive a damage, when **********ing a substrate. Usually, since thickness is thick compared with a piezo-electric thin film, generally as for the substrate which forms a piezo-electric thin film, wet etching is used. Since the etching reagent of strong acid nature and strong-base nature is used as an etching reagent, in order to ********** to a piezo-electric thin film, there is wrap need using synthetic resin. Before substrate etching, beforehand, patterning of the lithography technology is used and carried out, and the electrode for a piezoelectric-device drive and wiring form it. At this time, synthetic resin is used also as an insulating layer and enables one formation of drive wiring. Moreover, wiring ejection to a different field from a piezo-electric thin film forming face and formation of a-like 3-dimensional spacial configuration etc. are enabled.
[0069] (Synthetic resin) if the synthetic resin of an organic system is distinguished still in detail -- plastics (thermoplastics, thermosetting resin, and a plastics secondary product (a film, a sheet, various forms, adhesives, paint) are included), synthetic fibers (nylon, polyester, acrylic, etc.), and synthetic rubber (a diene system, a non-diene system, thermoplastic elastomer, etc.) -- in addition to this, it classifies (a water-absorbing resin, a synthetic paper, synthetic leather, ion exchange resin, ion exchange membrane, biodegradability polymer, etc.)
[0070] Also in this, especially a desirable thing is synthetic resin classified into plastics. For example, as what is classified into plastics, they are thermoplastics, thermosetting resin, and the synthetic resin that takes the gestalt of a plastics secondary product. as a concrete thing -- as a resist -- a photoresist (a diazo naphthoquinone-novolak resin --) The copolymer containing a polymethylmethacrylate and methyl methacrylate, The poly methyl isopropenyl ketone, an cyclization polyisoprene-azide compound system resist, A phenol resin-azide compound system resist, a principal chain cutting-die electron ray positive resist, A dissolution suppression type electron beam resist, the constructed type electron ray negative resist of a bridge, an epoxy system negative-mold electron beam resist, A polyethylene system negative-mold electron beam resist, an alkaline-water solution development negative-mold electron beam resist, The dry film resist used for a chemistry multiplier system resist, etc. a printed wired board, etc., the resist for plating, ED resist, a LDI resist, a polyimide, and the poly BENZO oxazole resin system are raised. The thing of especially low absorptivity is desirable also in this, and at least one resin chosen from the positive-type photopolymer and the poly BENZO oxazole resin containing polyimide resin is desirable. The positive-type photopolymer containing especially polyimide resin has the desirable tradename "CRC-8000" series by Sumitomo Bakelite Co., Ltd. this resin -- prebaking 120degree C -- it can unite with a diaphragm for [ /] 4 minutes by printing on light exposure 250 mJ/cm2(in case of "CRC-8200")-400 mJ/cm2 (in the case of "CRC-8300"), and the conditions for 150 degrees C of the last hardening, 30 -320 degrees C / per minute, and 30 minutes
[0071] In addition, the material raised as an example is an example, and if it is synthetic resin, it is satisfactory.
[0072] Hereafter, the gestalt of operation of this invention is explained using drawing 8 J from drawing 1 A.
[0073] (Gestalt 1 of operation) The simple cross section of the piezo-electric formula actuator of this invention is shown in drawing 1 A - drawing 1 D. The piezoelectric device 3 formed by lower electrode 2a by which the laminating was carried out, and up electrode 2b uses synthetic

resin 4 as a configuration maintenance board so that strip-of-paper-like the piezo-electric thin film 1 and its piezo-electric thin film 1 may be put, and synthetic resin 4 is arranged so that a piezoelectric device 3 may be wrapped in. One edge of a piezoelectric device 3 is being fixed to the fixed part 5 through lower electrode 2a. Lower electrode 2a is pulled out through a fixed part 5, when a fixed part 5 is a conductor, when a fixed part 5 is an insulator, forms an outgoing line 6 on a fixed part 5, and is taken out. Up electrode 2b is connected to the up electrode outgoing line 6 through a through hole 7 by making into an insulating layer the synthetic resin 4 which is a configuration maintenance board. The object 8 to operate is attached in an edge opposite to a fixed part 5.

[0074] The substrate portion which forms a piezoelectric device 3 is removed by methods, such as etching, and drawing 1 A shows the structure which used synthetic resin 4 as the configuration maintenance board.

[0075] The substrate portion which forms a piezoelectric device 3 is removed using methods, such as etching, drawing 1 B uses synthetic resin 4 as a configuration maintenance board, and the structure which applied synthetic resin 4 to the etching portion of a piezoelectric device 3 as a protective layer further is shown.

[0076] By methods, such as etching, only a part is processed thinly and the substrate in which drawing 1 C forms a piezoelectric device 3 shows the structure which used the remainder of synthetic resin 4 and a substrate as the configuration maintenance board.

[0077] An example of structure even if a fixed part 5 is a conductor, when drawing 1 D does not want to carry out [ fixed part ] the seal of approval of the direct voltage for an insulator or a fixed part is shown. You may form an outgoing line 6 on the direct fixed part 5 without forming the synthetic resin 4 on a fixed part 5, when a fixed part 5 is an insulator. Moreover, when a fixed part 5 is a conductor, as shown in drawing 1 D, synthetic resin 4 is formed on a fixed part 5, and an outgoing line 6 is formed on it. In addition, although it has composition which removed all the substrates of a piezoelectric device 3 to drawing 1 D, and formed the synthetic resin 4 of a protective layer in it, it is possible to pull out lower electrode 2a like drawing 1 D similarly with the structure of drawing 1 A which does not form synthetic resin 4, and the structure of drawing 1 C which removed a part of substrate of a piezoelectric device 3.

[0078] Only by the synthetic resin 4 which is a configuration maintenance board, rigidity may add reinforcing materials 30 to a low case, as shown in drawing 1 E - drawing 1 G. Drawing 1 E shows the case where reinforcing materials 30 are added between up electrode 2b and synthetic resin 4. Drawing 1 F shows the case where reinforcing materials 30 are added on the synthetic resin 4 which is a configuration maintenance board. Drawing 1 G shows the case where reinforcing materials 30 are added to the bottom of lower electrode 2a. As reinforcing materials, they are a metal membrane, an oxide film, etc. A spatter, a vacuum deposition, plating, etc. are used as the membrane formation method. About about 1-5 micrometers of thickness are desirable.

[0079] Moreover, as shown by drawing 1 D, it may form so that a piezoelectric device may be wrapped in synthetic resin from both sides, or thickness of the synthetic resin 4 which is a configuration maintenance board may be thickened. The method of applying synthetic resin 4 has the spinner method (spin coater), the rolling method, dip coating, a spray method, the desirable ink-jet method, etc.

[0080] Next, operation is shown using drawing 2 A - drawing 2 C. Drawing 2 A shows the state where seal-of-approval voltage is not applied. The state where drawing 2 B applied (+) to the up electrode, and applied the seal-of-approval voltage of (-) to the lower electrode is shown, and the state where drawing 2 C applied (-) to the up electrode, and applied the seal-of-approval voltage of (+) to the lower electrode is shown. In drawing 2 B, if seal-of-approval voltage is applied, the variation rate of deltax and delta y will be obtained. Moreover, in drawing 2 C, if seal-of-approval voltage is applied, delta x and in drawing 2 B, the variation rate of deltay of an opposite direction will be obtained. The desirable displacement length of delta x is the range of one to 5 micrometer, and the desirable displacement length of deltay is the range of ten to 30 micrometer. Moreover, when two actuators are used like two sides of a triangle, range ****'s of one to 2 micrometer is desirable to the direction of tracking.

[0081] The above-mentioned operation can obtain a comparatively big variation rate from

obtaining a variation rate to the Lord of a piezo-electric thin film using the deflection of the thickness direction. Moreover, control high-speed and highly precise by making drive frequency high is possible.

[0082] The above is the simple structure and the operating state of the piezo-electric formula actuator of this invention.

[0083] (Gestalt 2 of operation) The manufacturing method of the piezo-electric formula actuator shown in drawing 3 A-L with the gestalt 1 of operation is shown. First, drawing 3 A-L forms membranes directly to the substrate which processed the actuator configuration, and shows the manufacturing method at the time of removing the whole substrate. In this case, the substrate itself is beforehand processed into an actuator configuration, a piezo-electric thin film is formed after that, and the process which gives still more nearly partial processing is shown. Therefore, the substrate 40 used needs for it to be possible to keep almost at least 500 degrees C or more of configurations which is the membrane formation temperature at the time of membrane formation at the 1st. And it is raised that it is easy to process it into the 2nd as an actuator. As a substrate 40 to be used, a metal substrate is mainly desirable and the substrate stainless steel, aluminum, copper, whose titanium, etc. are mainly principal components is desirable from membrane formation temperature, processability, etc. Moreover, a magnesium oxide (MgO), a crystal glass, etc. are desirable.

[0084] In processing a substrate 40 into an actuator configuration, it processes it using etching, fabrication, and the pressing method. Although fabrication, the pressing method, etc. are advantageous if it says in respect of cost, in a process-tolerance side, etching processing is advantageous. Which processing method is used should just choose in respect of the process tolerance of the object which needs processing then, and cost.

[0085] Next, membrane formation is explained. About membrane formation, a metal mask etc. is used at the time of the method and membrane formation which process the piezo-electric thin film after membrane formation into an element configuration, and the method of making it not attach a piezo-electric thin film is in it except a required place. It is the difference in whether about membrane formation, a metal mask is set beforehand and membranes are formed, or membranes are formed to the whole processing substrate. The case where it uses with the case where a metal mask is not used, using drawing 3 A-L is explained.

[0086] First, the method of forming membranes when not using a metal mask is shown in drawing 3 A-F. After setting a processing substrate to a substrate electrode holder, it puts in in the chamber of a sputtering system and is made a vacua. It checks that substrate temperature has become about 500 degrees C or more, and the platinum (Pt) which serves both as 50nm of thickness and lower electrode 2a the titanium (Ti) which is the adhesion layer 9 is formed by about 50-200nm of thickness. Titanium (Ti) 9 is used in order to raise the bond strength of a substrate 40 and platinum (Pt). For this reason, you may form direct platinum (Pt) on a substrate without forming titanium (Ti), when the bond strength of a substrate 40 and Pt layer is high. Next, PbLiTi of the ground layer 10 which helps the crystal orientation of PbZrTiO3 of the lead-titanate system which is the piezo-electric thin film 1 is formed by 10-50nm thickness. Then, 1-6 micrometers of PbZrTiO(s)3 of the piezo-electric thin film 1 are formed. The thickness of PbZrTiO3 changes by the torque needed when it actuator-izes. In the case of the same area, the torque of a piezo-electric thin film is in direct proportion to thickness, and becomes large. The platinum (Pt) which is up electrode 2b, or Au(gold) is formed in thickness of 100-200nm after forming PbZrTiO3 (PLT film).

[0087] Next, the method of forming membranes in the case of forming membranes using a metal mask is shown in drawing 3 G-L. After setting a processing substrate to a substrate electrode holder, the metal mask 11 is set from on the. At this time, positioning is correctly performed using a gage pin etc. After fixing to a substrate electrode holder by the screw stop etc., it puts in in the chamber of a sputtering system and is made a vacua. It checks that substrate temperature has become about 500 degrees C or more, and the platinum (Pt) which serves both as 50nm in thickness and lower electrode 2a the titanium (Ti) which is the adhesion layer 9 is formed in thickness of about 50-200nm. Titanium (Ti) 9 is used in order to raise the bond strength of a substrate 40 and platinum (Pt). For this reason, you may form direct platinum (Pt)

on a substrate without forming titanium (Ti), when the bond strength of a substrate 40 and Pt layer is high.
[0088] Next, PbLiTi of the ground layer 10 which helps the crystal orientation of PbZrTiO3 of the lead-titanate system which is the piezo-electric thin film 1 is formed in thickness of 10-50nm. Then, PbZrTiO3 of the piezo-electric thin film 1 is formed in thickness of 1-6 micrometers. The thickness of PbZrTiO3 changes by the torque needed when it actuator-izes. In the case of the same area, the torque of a piezo-electric thin film is in direct proportion to thickness, and becomes large.
[0089] The platinum (Pt) which is up electrode 2b, or Au(gold) is formed in thickness of 100-200nm after forming PbZrTiO3. When changing a pattern with the film which forms membranes, the metal mask 11 prepares only the number of sheets, and is exchanged. Moreover, by one pattern, when good, it is not necessary to exchange the metal mask 11.
[0090] Next, a piezoelectric device 3 (lower electrode 2a / piezo-electric thin film 1 / up electrode 2b) is processed using lithography technology etc., and explanation of processing of the substrate for transposing a configuration maintenance board to synthetic resin is given using drawing 4 A-I.
[0091] Drawing 4 A-F is a method of processing it when not using a metal mask. First, synthetic resin 12 was applied to the up electrode 2b page. At this time, what synthetic resin can patternize like a resist or a photosensitive polyimide formed the through hole or the portion which is not partially covered by synthetic resin 12 for pulling out up electrode 2b. Wiring is formed using plating etc. In using the synthetic resin which cannot be patternized, it forms a circuit pattern beforehand on a substrate, the drawer portion of an electrode is created, after that, synthetic resin 12 is applied or synthetic resin is partially removed 12 times using laser processing etc. It applies using the spinner method, the rolling method, or dip coating as a method of applying synthetic resin 12. At this time, it sticks and the rear face (field opposite to the field which is forming the piezo-electric thin film 1) of the processing substrate 40 is fixed so that a crevice may not be vacant in flat substrates, such as glass. The synthetic resin applied by this fixation is wearing the field where up electrode 2b of the piezoelectric-device 3 section is formed, and the cross section of the piezo-electric thin film 1, and is hardly applied to the rear face of the processing substrate 40.
[0092] It applies so that the applied synthetic resin 12 may surely cover the cross-section portion of the piezo-electric thin film 1, as shown in drawing. This is for the piezo-electric thin film 1 to prevent **********ing at the etching process of the piezoelectric device 3 which is the following process, and the etching process of a substrate portion. Since intensity is risen further, the thermostat is used for the applied synthetic resin 12, and it raises and stiffens temperature. While the etching-proof effect raises by this hardening, insulation resistance increases and it can use also as an insulating layer for wiring. Desirable synthetic resin is the positive-type photopolymer containing said polyimide resin, for example, the resin of the tradename "CRC-8000" series by Sumitomo Bakelite Co., Ltd.
[0093] After covering a required place by synthetic resin 12, up electrode 2b is **********ed. Although up electrode 2b generally has the dry etching method, the wet etching method, etc. as the etching method using gold (Au), platinum (Pt), etc., in the case of the dry etching method, it **********s using argon gas (Ar). On the other hand, in the case of wet etching, to gold (Au), it etches using the mixed liquor of potassium iodide (KI), iodine (I2), and water (H2O) etc.
[0094] Next, the piezo-electric thin film 1 and the PLT film of the ground layer 10 were **********ed. When thickness is thin, when thickness is thick, the wet etching method is used using the dry etching method. In the case of the dry etching method, it **********s using argon gas (Ar) like the case of gold (Au) and platinum (Pt). In the case of wet etching, it etches using a **-ized ammonium solution and ****, and ******.
[0095] Then, lower electrode 2a is **********ed. Generally as for lower electrode 2a, platinum (Pt) is used. In the case of the dry etching method, it **********s using argon gas (Ar). On the other hand, in the case of wet etching, as an etching reagent, the mixed liquor of a potassium cyanide, persulfuric-acid ammonium, and water is used.
[0096] After etching, the synthetic resin 12 used as an etching mask may be removed, or may be

used as a configuration maintenance board as it is. When synthetic resin 12 is removed, synthetic resin 12 is applied again. The method of application uses the same method as the above.

[0097] Next, the etching process of a substrate 40 is explained. in the case of metals, such as stainless steel, aluminum, and copper, a substrate 40 is partial using a ferric-chloride solution, a copper-nitrate solution, etc. -- or it all **********s Although the etching method also has various methods, such as a spray method and dip coating, when a spray method is used, an etch rate and homogeneity can be controlled by the size of **** of the etching reagent which blows off from a spray, a blasting pressure, the temperature of an etching reagent, etc. Although it will ********** together with a substrate 40 if the piezo-electric thin film 1 is not covered by synthetic resin 12 at this time, since it is covered by synthetic resin 12 in last distance, it is satisfactory. That is, it is important to cover the piezo-electric thin film 1 using synthetic resin 12. Especially, synthetic resin 12 has a property strong against an acid etching reagent, and has turned to such a process. Moreover, when **********ing a substrate 40 altogether, after a substrate 40 **********s, Pt which is lower electrode 2a strong against the etching reagent of an acid plays a stopper's role over an etching reagent. Thus, after a substrate 40 **********s, the synthetic resin 12 which was carrying out the role of the pattern for etching plays the role of a configuration maintenance board. usually -- the case where the piezo-electric thin film 1 is imprinted to other configuration maintenance boards other than substrate 40 -- a piezoelectric device 3 and configuration maintenance -- although the method of using electric conduction adhesives etc. for a wooden floor, and pasting up on it is common, in the case of a very small element, it is not desirable in precision Therefore, if such a method is used, it is possible to very small processing, and it will make it possible to imprint to other configuration maintenance boards other than a substrate, without using adhesives etc.

[0098] Drawing 4 G-I is a method of processing it in the case of using a metal mask. A metal mask is used at the time of membrane formation of a piezoelectric device 3, and the piezoelectric device 3 is formed only into the required portion. For this reason, the etching process of the piezoelectric device 3 explained by the method of processing it when not using the metal mask shown by drawing 4 A-F is skipped. Therefore, synthetic resin 12 is applied after membrane formation, the piezoelectric-device 3 section is covered by synthetic resin 12, and the structure where the etching reagent which **********s a substrate cannot be touched is formed. About etching of a substrate 40, it is the same as that of the above.

[0099] Drawing 5 A-I forms membranes directly to the substrate 40 which processed the actuator configuration, and shows the manufacturing method in the case of processing the whole substrate thinly by the etching method, the lap method, the polishing method, or the CMP method.

[0100] Since the method of forming a piezoelectric device, the method of applying synthetic resin 12, the hardening method, and the method of forming wiring are the same as the case of drawing 4 A-I, explanation is omitted. A greatly different process is the method of processing it thinly. Then, detail of the method is given below. In using the etching method first, in the case of metals, such as stainless steel, aluminum, copper, and titanium, a substrate 40 **********s using a ferric-chloride solution, a copper-nitrate solution, etc. Although it will ********** together with a substrate 40 if the piezo-electric thin film 1 is not covered by synthetic resin 12 at this time, since it is covered by synthetic resin 12 in last distance, it is satisfactory. That is, it is important to cover the piezo-electric thin film 1 using synthetic resin 12. Especially, synthetic resin 12 has a property strong against an acid etching reagent, and has turned to such a process. It is decided in a substrate 40 how much it will ********** by the mechanical strength and the amount of displacement of an actuator which are needed. Although control of the amount of etching changes with etching reagents to be used, it is performed by the concentration of an etching reagent, etching time, the temperature of an etching reagent, and the etching method to be used. The etching method mainly has a spray method and dip coating. Especially a spray method can control an etch rate and homogeneity by the size of **** of the etching reagent which blows off from a spray, a blasting pressure, the temperature of an etching reagent, etc.

[0101] Attaching the fixed substrate 40 in a fixture, putting on a lap board, and spraying a diamond slurry etc. on a substrate, the lap method and the polishing method rotate a lap board by constant speed, and delete a substrate.
[0102] Here, although the CMP (chemical mechanical polishing : chemical and mechanical compound polish) method resembles the lap method and the polishing method, it etches chemically, spraying solutions acid instead of, such as a diamond slurry. It is the method of processing the thickness of a substrate thinly using such a method.
[0103] Drawing 6 A-G forms membranes directly to the substrate which processed the actuator configuration, and shows the manufacturing method at the time of removing a part of all substrates. Drawing 6 A-D is drawing showing the distance element-ized after membrane formation using lithography technology etc. without using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. Since the processing process of a piezoelectric device was the same as that of drawing 4 A-C or drawing 5 A-C when not using a metal mask, illustration was omitted.
[0104] On the other hand, drawing 6 E-G is drawing showing the distance which performs element processing using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. Since the method of forming a piezoelectric device 3, the method of applying synthetic resin 12, the hardening method, and the method of forming wiring are the same as the case of drawing 3 A-L, explanation is omitted. A greatly different process is forming the pattern from which synthetic resin's 12 was applied also to the rear face (field opposite to the field which is forming the piezo-electric thin film) of the processing substrate 40, and only the part's removed synthetic resin 12. in drawing 6 A-D, a piezo-electric thin film is formed on the front face of a substrate 40, and it is alike on it, and after applying and hardening synthetic resin 12, synthetic resin 12 is applied to the rear face (field opposite to the field which is forming the piezo-electric thin film 1) of the processing substrate 40 The rear face of the processing substrate 40 is turned up, and it fixes to smooth substrates, such as glass. And synthetic resin 12 is applied by the spinner method or the rolling method, and dip coating. If synthetic resin 12 is photosensitivity or an ultraviolet-rays hardening type at this time, it will expose and patternize using a mask etc. If it is neither photosensitivity nor an ultraviolet-rays hardening type, it will patternize after an application using laser etc. Especially the aforementioned pattern is a pattern for removing the substrate 40 of the piezoelectric-device 3 section, namely, only the substrate top of the piezoelectric-device 3 section is made not to be covered by synthetic resin 12. In order to raise the acid-proof intensity of the applied synthetic resin 12, and a mechanical strength after this patternizing, the thermostat is used, and temperature is raised and stiffened. A substrate 40 is removed using the etching method after that. In order to remove by the etching method, the patternized field is turned up and it fixes to a glass substrate etc. And the substrate 40 of the portion which is not covered by synthetic resin 12 using a spray method, dip coating, etc. is removed. In the case of metals, such as stainless steel, aluminum, copper, and titanium, a substrate 40 uses a ferric-chloride solution, a copper-nitrate solution, etc.
[0105] All substrates **********, the platinum (Pt) of lower electrode 2a serves as a stopper, and etching is completed. In this process, a substrate 40 is removed and synthetic resin 12 replaces as a configuration maintenance board. Moreover, a piezoelectric device 3 can be imprinted, without using adhesives etc.
[0106] Drawing 6 E-G is a method of processing it in the case of using a metal mask. A metal mask is used at the time of membrane formation of a piezoelectric device 3, and the piezoelectric device 3 is formed only into the required portion. For this reason, the etching process of the piezoelectric device 3 explained by the method of processing it when not using the metal mask shown by drawing 6 A-D is skipped. Therefore, synthetic resin 12 is applied after membrane formation, the piezoelectric-device 3 section is covered by synthetic resin 12, and the structure where the etching reagent which **********s a substrate cannot be touched is formed. About etching of a substrate 40, it is the same as that of the above.
[0107] Drawing 7 A-G forms membranes directly to the substrate which processed the actuator

configuration, and shows the manufacturing method in processing which made thickness of a substrate thin. Drawing 7 A-D is drawing showing the distance element-ized after membrane formation using lithography technology etc. without using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. Since the processing process of a piezoelectric device was the same as that of drawing 4 A-C or drawing 5 A-C when not using a metal mask, illustration was omitted.

[0108] On the other hand, drawing 7 E-G is drawing showing the distance which performs element processing using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. Since the method of forming a piezoelectric device 3, the method of applying synthetic resin 12, the hardening method, the method of forming wiring, and the pattern formation method of synthetic resin 12 are the same as the case of drawing 3 A-L, explanation is omitted. Etching a substrate 40 differ greatly, controlling an etch rate and homogeneity. It is decided 40 how much will ********** a substrate by the mechanical strength and the amount of displacement of an actuator which are needed. Although control of the amount of etching changes with etching reagents to be used, it is the concentration of an etching reagent, etching time, the temperature of an etching reagent, and the etching method to be used. The etching method mainly has a spray method and dip coating. Especially a spray method can control an etch rate and homogeneity by the size of **** of the etching reagent which blows off from a spray, a blasting pressure, the temperature of an etching reagent, etc.

[0109] The actuator into which only the whole or the part processed the thickness of a substrate thinly is producible by controlling the above conditions.

[0110] Drawing 8 A-J shows the manufacturing method of the actuator in the case of removing the whole substrate using the substrate 40 which is not processed into an actuator configuration.

[0111] Drawing 8 A-F is drawing showing the distance element-ized after membrane formation using lithography technology etc. without using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. On the other hand, drawing 8 G-J is drawing showing the distance which performs element processing using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. It is needed for the substrate 40 used to be able to keep almost at least 500 degrees C or more of configurations which is the membrane formation temperature at the time of membrane formation at the 1st. And to be easily removable by etching etc. is needed for the 2nd. As a substrate 40 to be used, a metal substrate is mainly desirable and the substrate stainless steel, aluminum, copper, whose titanium, etc. are mainly principal components is desirable from membrane formation temperature, processability, etc. Moreover, a magnesium oxide (MgO) is also desirable.

[0112] About membrane formation, a metal mask etc. is used at the time of the method and membrane formation which process the piezo-electric thin film after membrane formation into an element configuration, and the method of making it not attach a piezo-electric thin film is in it except a required place. It is better to process it using lithography technology from the metal mask method, when precision is required.

[0113] The metal mask method determines the pattern beforehand with the film which forms membranes, and only exchanges it at the time of membrane formation. Since it is the same distance as the explanation in the case of using with the case where a metal mask is not used by drawing 3 A-L, it omits.

[0114] Next, a piezoelectric device 3 (lower electrode 2a / piezo-electric thin film 1 / up electrode 2b) is processed using lithography technology etc., and explanation of processing of the substrate for transposing a configuration maintenance board to synthetic resin is given using drawing 8 A-J.

[0115] Drawing 8 A-F is a method of processing it when not using a metal mask. First, synthetic resin 12 is applied to up electrode 2b page. At this time, what synthetic resin 12 can patternize

like a resist or a photosensitive polyimide forms the through hole or the portion which is not partially covered by synthetic resin 12 for pulling out up electrode 2b. Wiring is formed using plating etc. In using the synthetic resin which cannot be patternized, it forms a circuit pattern beforehand on a substrate, and the drawer portion of an electrode is created, and synthetic resin 12 is applied after that. Or synthetic resin is partially removed 12 times using laser processing etc. It applies using the spinner method, the rolling method, dip coating, a spray method, the ink-jet method, etc. as a method of applying synthetic resin 12. At this time, it sticks and the rear face (field opposite to the field which is forming the piezo-electric thin film 1) of a substrate 40 is fixed so that a crevice may not be vacant in flat substrates, such as glass. The synthetic resin applied by this fixation is wearing the field where up electrode 2b of the piezoelectric-device 3 section is formed, and the cross section of the piezo-electric thin film 1, and is hardly applied to the rear face of a substrate 40.

[0116] It applies so that the applied synthetic resin 12 may surely cover the cross-section portion of the piezo-electric thin film 1, as shown in drawing. This is for the piezo-electric thin film 1 to prevent **********ing in the etching process of the piezoelectric device 3 which is the following distance, and the etching distance of a substrate portion. In order to raise intensity further, the thermostat is used for the applied synthetic resin 12, and it raises and stiffens temperature. While the etching-proof effect increases by this hardening, insulation resistance increases and it can use also as an insulating layer for wiring.

[0117] After covering a required place by synthetic resin 12, up electrode 2b is **********ed. Although gold (Au), platinum (Pt), etc. are generally used and up electrode 2b has the dry etching method, the wet etching method, etc. as the etching method, in the case of the dry etching method, it **********s using argon gas (Ar). On the other hand, in the case of wet etching, to gold (Au), it etches using the mixed liquor of potassium iodide (KI), iodine (I2), and water (H2O) etc.

[0118] If it **********s, up electrode 2b will remove a resist, and will apply and patternize the resist for piezo-electric thin film 1 processing again. As long as the resist for up electrode 2b is excellent also in wet etching-proof nature with the shape of a pattern and isomorphism which **********s a piezo-electric thin film at this time, you may use the resist for up electrode 2b processing as it is.

[0119] Next, the piezo-electric thin film 1 and the PLT film of the ground layer 10 are **********ed. When thickness is thin, when thickness is thick, the wet etching method is used using the dry etching method. In the case of the dry etching method, it **********s using argon gas (Ar) like the case of gold (Au) and platinum (Pt). In the case of wet etching, it etches using an ammonium-fluoride solution and fluoric acid. The etching method warms the buffer DOFUTSU acid put into the beaker at about 60 degrees C, and is immersed the whole substrate 40 into it. Buffered fluoric acid is always stirred so that concentration may become fixed. It is made to wash and dry with the pure water after etching. A resist is removed after that, and a resist is again exposed and developed to an application and a lower electrode 2a etching pattern. As for the pattern for lower electrode 2a, at this time, it is desirable to form somewhat more greatly than the configuration of the piezo-electric thin film 1. By this, the structure where the piezo-electric thin film 1 is wrapped in by the resist of lower electrode 2a and synthetic resin 12 etc. can be produced, and there is no fear of the piezo-electric thin film 1 being exposed to the etching reagent at the time of substrate 40 removal.

[0120] Then, lower electrode 2a is **********ed. Generally as for lower electrode 2a, platinum (Pt) is used. In the case of the dry etching method, it **********s using argon gas (Ar). On the other hand, in the case of wet etching, as an etching reagent, the mixed liquor of a potassium cyanide, persulfuric-acid ammonium, and water is used.

[0121] After etching, the synthetic resin 12 used as an etching mask may be removed, or may be used as a configuration maintenance board as it is. When synthetic resin 12 is removed, synthetic resin 12 is applied again. In addition, you may use as a configuration maintenance board or an actuator pattern as it is, and the upper shell and also other synthetic resin 12 of this resist may be applied without removing the resist for lower electrode 2a etching depending on the specification of the actuator to produce, and you may form a configuration maintenance board or

an actuator pattern. At this time, what synthetic resin 12 can patternize like a resist or a photosensitive polyimide forms the through hole or the portion which is not partially covered by synthetic resin 12 for pulling out up electrode 2b's. Wiring is formed using plating etc. In using the synthetic resin 12 which cannot be patternized, it forms a circuit pattern beforehand on a substrate, and the drawer portion of an electrode is created, and synthetic resin 12 is applied after that. Or synthetic resin 12 is partially removed using laser processing etc.
[0122] If the configuration maintenance board by synthetic resin 12 or actuator pattern formation is completed, in order to raise intensity for synthetic resin 12 further, the thermostat will be used, and temperature will be raised and stiffened. While the etching-proof effect raises by this hardening, insulation resistance increases and it can use as an insulating layer for wiring.
[0123] after hardening and next time -- a substrate 40 -- the process which removes all is explained After hardening synthetic resin 12, a synthetic-resin 12 side is fixed so that flat boards, such as glass, may be touched. And the substrate 40 of the portion which is not covered by synthetic resin 12 using a spray method, dip coating, etc. is removed. In the case of metals, such as stainless steel, aluminum, copper, and titanium, a substrate 40 uses a ferric-chloride solution, a copper-nitrate solution, etc.
[0124] A substrate 40 **********s altogether, the platinum (Pt) of lower electrode 2a serves as a stopper, and etching is completed. In this process, a substrate 40 is removed and synthetic resin 12 replaces as a configuration maintenance board. Moreover, a piezoelectric device 3 can be imprinted, without using adhesives etc. Moreover, portions other than a configuration maintenance board also become possible [ producing an actuator configuration and wiring freely by patternizing beforehand ].
[0125] Although the ejection of lower electrode 2a is not illustrated, it may prepare the through hole for forming using plating etc. through an insulating layer, or taking out the electrode from a lower electrode beforehand at the time of processing of a piezo-electric thin film in the synthetic resin which is an insulating layer after removing a substrate, and it may take it out in the drawing upper part through the through hole.
[0126] Drawing 8 G-J is a method of processing it in the case of using a metal mask. A metal mask is used at the time of membrane formation of a piezoelectric device 3, and the piezoelectric device 3 is formed only into the required portion. For this reason, the etching process of the piezoelectric device 3 explained by the method of processing it when not using the metal mask shown by drawing 8 G-J is skipped. Therefore, synthetic resin 12 is applied after membrane formation, the piezoelectric-device 3 section is covered by synthetic resin 12, and the structure where the etching reagent which **********s a substrate cannot be touched is formed. About etching of a substrate 40, it is the same as that of the above. Although the ejection of lower electrode 2a is not illustrated, it may prepare the through hole for forming using plating etc. through an insulating layer, or taking out the electrode from a lower electrode beforehand at the time of processing of a piezo-electric thin film in the synthetic resin which is an insulating layer after removing a substrate, and it may take it out in the drawing upper part through the through hole.
[0127] Drawing 9 A-E shows the manufacturing method of the actuator in the case of removing a part of substrate 40 while processing a substrate using the substrate 40 which is not processed into an actuator configuration so that it may become a part [ an actuator ].
[0128] Drawing 9 A-E is drawing showing the distance element-ized after membrane formation using lithography technology etc. without using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. On the other hand, since drawing 8 A-F has described in detail the distance which performs element processing using a metal mask, it omits here.
[0129] Since the method of forming a piezoelectric device 3, the method of applying synthetic resin 12, the hardening method, and the method of forming wiring are the same as the case of drawing 8 A-J, explanation is omitted. A greatly different process is forming the pattern from which synthetic resin's 12 was applied also to the rear face (field opposite to the field which is forming the piezo-electric thin film) of a substrate 40, and only the part's removed synthetic resin 12. In drawing 9 A-E, a piezo-electric thin film is formed on the front face of a substrate

40, and after applying and hardening synthetic resin 12 on it, synthetic resin 12 is applied to the rear face (field opposite to the field which is forming the piezo-electric thin film 1) of a substrate 40. The rear face of a substrate 40 is turned up and it fixes to smooth substrates, such as glass. And synthetic resin 12 is applied by the spinner method, the rolling method, or dip coating. If synthetic resin 12 is photosensitivity or an ultraviolet-rays hardening type at this time, it will expose and patternize using a mask etc. If it is neither photosensitivity nor an ultraviolet-rays hardening type, it will patternize after an application using laser etc. Especially the aforementioned pattern is a pattern for removing the substrate 40 of the piezoelectric-device 3 section, namely, only the substrate top of the piezoelectric-device 3 section is made not to be covered by synthetic resin 12. In order to raise the acid-proof intensity of the applied synthetic resin 12, and a mechanical strength after this patternizing, the thermostat is used, and temperature is raised and stiffened. A substrate 40 is removed using the etching method after that. In order to remove by the etching method, the patternized field is turned up and it fixes to a glass substrate etc. And the substrate 40 of the portion which is not covered by synthetic resin 12 using a spray method, dip coating, etc. is removed. In the case of metals, such as stainless steel, aluminum, copper, and titanium, a substrate 40 uses a ferric-chloride solution, a copper-nitrate solution, etc.

[0130] All substrates **********, the platinum (Pt) of lower electrode 2a serves as a stopper, and etching is completed. In this process, a substrate 40 is removed and synthetic resin 12 replaces as a configuration maintenance board. Moreover, a piezoelectric device 3 can be imprinted, without using adhesives etc.

[0131] Although not illustrated, the ejection of lower electrode 2a will be taken out through a substrate, if a substrate is a conductive thing and there is. When a substrate is not conductivity, or when taking out from a substrate even if it is conductivity and there is trouble, the through hole for forming using plating etc. through an insulating layer, or taking out the electrode from a lower electrode beforehand at the time of processing of a piezo-electric thin film may be prepared in the synthetic resin which is an insulating layer after removing a substrate, and you may take out in the drawing upper part through the through hole.

[0132] Next, the method of processing it in the case of using a metal mask is explained. A metal mask is used at the time of membrane formation of a piezoelectric device 3, and the piezoelectric device 3 is formed only into the required portion. For this reason, the etching process of the piezoelectric device 3 explained by the method of processing it when not using the metal mask shown by drawing 8 A-F is skipped. Synthetic resin 12 is applied after membrane formation, the piezoelectric-device 3 section is covered by synthetic resin 12, and the structure where the etching reagent which **********s a substrate cannot be touched is formed. It is the same as that of the case where the above-mentioned metal mask is not used about etching of a substrate 40.

[0133] Drawing 10 A-D shows the manufacturing method of the actuator in the case of making the whole substrate thin by the etching method, the lap method, the polishing method, or the CMP method while processing a substrate using the substrate which is not processed into an actuator configuration so that it may become a part [ an actuator ].

[0134] Drawing 10 A-D is drawing showing the distance element-ized after membrane formation using lithography technology etc. without using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. On the other hand, since drawing 8 G-J has described in detail the distance which performs element processing using a metal mask, it omits here.

[0135] Since the method of forming a piezoelectric device 3, the method of applying synthetic resin 12, the hardening method, and the method of forming wiring are the same as the case of drawing 8 A-J, explanation is omitted. A greatly different process is the method of processing it thinly. Then, detail of the method is given below. In using the etching method first, in the case of metals, such as stainless steel, aluminum, copper, and titanium, a substrate 40 **********s using a ferric-chloride solution, a copper-nitrate solution, etc. Although it will ********** together with a substrate 40 if the piezo-electric thin film 1 is not covered by synthetic resin 12 at this time, since it is covered by synthetic resin 12 in last distance, it is satisfactory. That is, it

is important to cover the piezo-electric thin film 1 using synthetic resin 12. Especially, synthetic resin 12 has a property strong against an acid etching reagent, and has turned to such a process. It is decided in a substrate 40 how much it will ********** by the mechanical strength and the amount of displacement of an actuator which are needed. Although control of the amount of etching changes with etching reagents to be used, it can be performed by the concentration of an etching reagent, etching time, the temperature of an etching reagent, and the etching method to be used. The etching method mainly has a spray method and dip coating. Especially a spray method can control an etch rate and homogeneity by the size of **** of the etching reagent which blows off from a spray, a blasting pressure, the temperature of an etching reagent, etc.

[0136] Attaching the fixed substrate 40 in a fixture, putting on a lap board, and spraying a diamond slurry etc. on a substrate, the lap method and the polishing method rotate a lap board by constant speed, and delete a substrate.

[0137] Although the CMP method resembles the lap method and the polishing method, it etches chemically, spraying solutions acid instead of, such as a diamond slurry. The thickness of a substrate is thinly processed using such a method.

[0138] In these processes, a substrate is removed and synthetic resin replaces as a configuration maintenance board. Moreover, a piezoelectric device can be imprinted, without using adhesives etc. Moreover, portions other than a configuration maintenance board also become possible [ producing an actuator configuration and wiring freely by patternizing beforehand ].

[0139] Although not illustrated, the ejection of lower electrode 2a will be taken out through a substrate, if a substrate is a conductive thing and there is. When a substrate is not conductivity, or when taking out from a substrate even if it is conductivity and there is trouble, the through hole for taking out the electrode from a lower electrode beforehand at the time of processing of a piezo-electric thin film may be prepared in the synthetic resin which is an insulating layer, and you may take out in the drawing upper part through the through hole.

[0140] Drawing 11 A-E shows the manufacturing method of the actuator in the case of making a part of substrate thin while processing a substrate using the substrate which is not processed into an actuator configuration so that it may become a part [ an actuator ].

[0141] Drawing 11 A-E is drawing showing the distance element-ized after membrane formation using lithography technology etc. without using a metal mask about minimum and lower electrode 2a, the piezo-electric thin film 1, and membrane formation of the piezoelectric device 3 which consists of up electrode 2b. On the other hand, since drawing 8 G-J has described in detail the distance which performs element processing using a metal mask, it omits here.

[0142] Since the method of forming a piezoelectric device 3, the method of applying synthetic resin 12, the hardening method, and the method of forming wiring are the same as the case of drawing 8 A-J, explanation is omitted. Etching a substrate 40 differ greatly, controlling an etch rate and homogeneity. It is decided in a substrate 40 how much it will ********** by the mechanical strength and the amount of displacement of an actuator which are needed. Although control of the amount of etching changes with etching reagents to be used, it is the concentration of an etching reagent, etching time, the temperature of an etching reagent, and the etching method to be used. The etching method mainly has a spray method and dip coating. Especially a spray method can control an etch rate and homogeneity by the size of **** of the etching reagent which blows off from a spray, a blasting pressure, the temperature of an etching reagent, etc.

[0143] The actuator into which only the part processed the thickness of a substrate thinly is producible by controlling the above conditions. Although not illustrated, the ejection of lower electrode 2a will be taken out through a substrate, if a substrate is a conductive thing and there is. When a substrate is not conductivity, or when taking out from a substrate even if it is conductivity and there is trouble, the through hole for taking out the electrode from a lower electrode beforehand at the time of processing of a piezo-electric thin film may be prepared in the synthetic resin which is an insulating layer, and you may take out in the drawing upper part through the through hole.

[0144] (Gestalt 3 of operation) The fundamental composition of the two-step formula actuator of this invention is shown in drawing 12 .
[0145] A head support mechanism is constituted by the signal system (with no illustration) which joins the record regenerative circuit of an information recording device to the load beam (not shown) and the head element 13 which add a load to the slider 14 which flies or glides over the record-medium top carries the head element 13, and it rotates or runs, and the base plate 16 which fixes the suspension 15 which supports it, and a suspension 15 and a slider 14 electrically, and the part or whole is formed by one. Signal system lead wire and a suspension wire by the printed circuit directly or indirectly.
[0146] The actuators which carry out a minute drive are a suspension 15 and one apparatus, and are arranged between the sliders 14 and base plates 16 which constitute the head element 1.
[0147] As shown in drawing 13 A, this actuator consists of a piezo-electric thin film which constitutes the about 10-30-micrometer stainless steel used as a base material, and the minute driver element 18. The minute driver element 18 is bent so that it may become perpendicular to the disk side 19, and it takes structure.
[0148] Furthermore, as shown in drawing 13 B, the minute driving gear 18 accomplishes the angle of 15 degrees or more, respectively with the field which met the disk side at the center line of the longitudinal direction of a perpendicular and a suspension, and is constituted.
[0149] Moreover, the driver voltage of an opposite phase is given to each minute driver element 18 90 degrees, and expansion and contraction are repeated. The slider 14 and the head element 13 which were fixed to the suspension 15 and the suspension 15 by expansion and contraction are rotated like drawing 14 A. Furthermore, if driver voltage is made into an opposite phase, the slider 14 and the head element 13 which were fixed to the suspension 15 and the suspension 3 will be rotated to opposite direction like drawing 14 B.
[0150] The minute driver element 18 is arranged so that about 15 or more angles may be taken to the field 21 perpendicular to a disk side. This is for mitigating this influence, in order to tend to influence [ affect a slider 14 ] rotation of a desk (air viscous-friction force), when an angle is small (about zero - less than 15 degrees). Highly precise truck positioning is attained by the above composition.
[0151] In addition, although stainless steel was used as a base material which constitutes an actuator this time, what material is sufficient as long as it is the material which owns spring nature and thermal resistance and can secure a certain amount of rigidity as thickness is thin.
[0152] The composition at the time of applying synthetic resin 12 to drawing 15 , drawing 16 , and drawing 17 at the minute driver-element 18 section of the two-step formula actuator of this invention is shown.
[0153] the travel (variation rate) which rotates the slider 14 and the head element 13 by which the actuator was fixed to the suspension 15 when the rigidity of the minute driver-element 18 section is high -- the minute driver element 18 -- being independent (cantilever configuration) -- about [ changing / of distance ] -- it is set to one fourth
[0154] This cause is loss produced since 1 set of minute driver elements 18 fix the ends of an element, respectively and are restrained. Therefore, it becomes possible to tell the force which each driver element generates by using synthetic resin 12 for the minute driver-element 18 section efficiently to the slider 14 and the head element 13 which were fixed to the suspension 15 and the suspension 15, and a big variation rate is obtained.
[0155] [ whether all of the actuator section, a configuration maintenance board, etc. are replaced with material like synthetic resin 12 which is flexible and is elastic so that the variation rate of the minute driver element 18 may be enlarged as much as possible as a method using synthetic resin 12, as shown in drawing 15 A-B, and ] As shown in drawing 16 A-B, only minute driver-element 18 portion is replaced, or as shown in drawing 17 A-B, the actuator section, a configuration maintenance board, etc. are altogether made thin using the etching method etc., or only minute driver-element 18 portion is made thin using the etching method etc.
[0156] Rigidity is reduced by using these methods and it becomes possible to enlarge the variation rate of the minute driver-element 18 section. Moreover, it is eased by the flexible structure of the minute driver-element 18 section, and the state where the minute driver

element 18 of a couple restrains to each other, and is falling efficiency also leads to expansion of a variation rate.
[0157] Moreover, as shown in drawing 18 , you may form the restricted relief means 20 in the ends of the minute driver element 18 by synthetic resin 12.
[0158] Since drawing 3 A - drawing 11 E described the manufacturing method in detail, it omits.
[0159] In addition, as shown in drawing 15 , it is flexible, and when rigidity falls [ portions other than a mechanical component ] and a problem arises in a mechanical characteristic by replacing all of the actuator section, a configuration maintenance board, etc. with an elastic material like synthetic resin 12, it is solved by adding the supporting point 17 by synthetic resin 12, as shown in drawing 19 .
[0160] (Gestalt 4 of operation) Another fundamental composition of the two-step formula actuator of this invention is shown in drawing 20 . Lower electrode 2a, the piezo-electric thin film 1, and the piezoelectric device 3 that consists of up electrode 2b remove a substrate 40 altogether, and is imprinted by synthetic resin 12. Synthetic resin 12 forms an actuator configuration and constitutes a piezoelectric device 3 in the beam structured division.
[0161] Since drawing 3 A - drawing 11 E described the manufacturing method in detail, it omits.
Drawing 21 A-D is drawing having shown the operation. Drawing 21 A shows operation at the time of applying seal-of-approval voltage to the piezoelectric device 3 located in the right-hand side of a drawing. If the portion of a drawing top is fixed and voltage is applied to the beam portion on the right-hand side of a drawing, a piezoelectric device 3 will bend and the free end opposite to the fixed end will displace on the right. On the other hand, if voltage is applied to the beam portion on the left-hand side of a drawing, a piezoelectric device 3 will bend and the free end opposite to the fixed end will displace drawing 21 B on the left.
[0162] (Gestalt 5 of operation) The wiring structure of the piezo-electric formula actuator of this invention is shown in drawing 22 A1, 22A2, 22B1, 22 B-2, 22C1, 22C2, 22D1, and 22D2.
[0163] Drawing 22 A1 is the **** view after bending with a substrate, in order to form wiring and to form a three-dimensions-spacial configuration. Drawing 22 A2 is the cross section after performing bending processing according wiring to formation and a press.
[0164] Lower electrode 2a takes out a substrate 40 from a substrate 40 using the quality of the materials, such as conductive stainless steel material. On the other hand, the ejection of up electrode 2b patternizes synthetic resin 4 as an insulating layer on up electrode 2b after processing the piezoelectric device on a substrate 40. In order to take up electrode 2b and conductivity, the through hole 7 is formed in the synthetic resin 4 which is an insulating layer. After heat-treating and stiffening the synthetic resin 4 of an insulating layer in nitrogen, copper wiring is formed using plating. The synthetic resin 4 for covering is applied and patternized, and it is made to heat-treat and harden in nitrogen after forming copper wiring. Then, it bends using a press machine with a substrate, and a three-dimensions-spacial configuration is formed.
[0165] Thus, it becomes possible to take out an electrode, without spoiling the conductivity of the bent wiring portion by forming wiring using synthetic resin 4.
[0166] Drawing 22 B1 is a **** view when bending so that wiring may not spoil conductivity by cutting etc., and removing the substrate of a portion, when bending with a substrate, in order to form wiring and to form a three-dimensions-spacial configuration.
[0167] Drawing 22 B-2 is the cross section after performing bending processing according wiring to formation and a press.
[0168] Since it is the same as that of drawing 22 A1 and drawing 22 A2, the formation method of a wiring portion is omitted. Etching removal is performed for the substrate of the place equivalent to a bending portion after forming wiring structure using wet etching etc. For example, what is necessary is just to use a ferric-chloride solution, if a substrate is a metal like stainless steel. In order to form a three-dimensions-spacial configuration by using such structure, when bending with a substrate, wiring can be prevented from spoiling conductivity by cutting etc. Thus, it becomes possible to take out an electrode, without spoiling the conductivity of the wiring portion which the force of having bent at the time of bending processing by press working of sheet metal, and joining wiring of a portion was distributed, and was bent, if the substrate of a bending portion is removed while forming wiring using synthetic resin 4.

[0169] Drawing 22 C1 is the **** view after bending with a substrate contrary to drawing 22 A1, in order to form wiring and to form a three-dimensions-spacial configuration. Drawing 22 C2 is the cross section after forming wiring and performing bending processing by the press. Since it is the same as that of drawing 22 A1, the formation method of wiring and the method of creating the bending spacial configuration by press working of sheet metal are omitted. In this case, since wiring structure is located in the outside of a substrate 40, the wiring itself becomes the structure pulled by the substrate and possibility of spoiling conductivity becomes high. Therefore, thickness of the copper wiring formed of plating compared with the case where wiring is formed, inside a substrate 40 is thickened. Moreover, it becomes possible to form wiring on a three-dimensions-spacial configuration by thickening some thickness of the synthetic resin 4 used as an insulating layer.
[0170] Drawing 22 D1 is a **** view when bending so that wiring may not spoil conductivity by cutting etc., and removing the substrate of a portion, when bending with a substrate, in order to form wiring and to form a three-dimensions-spacial configuration.
[0171] Drawing 22 D2 is the cross section after performing bending processing according wiring to formation and a press.
[0172] It bends in order to raise further the reliability of the three dimensions solid wiring structure of drawing 22 C1, and the substrate 40 of a portion is removed. Thus, it becomes possible to take out an electrode, without spoiling the conductivity of the wiring portion which the force of having bent at the time of bending processing by press working of sheet metal, and joining wiring of a portion was distributed, and was bent, if the substrate of a bending portion is removed while forming wiring using synthetic resin 4.
[0173] The actuator of this invention is applicable to the following use.
The thing using the device which deflects <optical relation (1)> light. For example, a printer, a projection display, a bar code reader, a scanner, etc.
(2) Thin film bitter taste CHUETEDDO mirror array.
(3) Micro optical element : an optical switching element, a focusing device, a focal adjustable mirror, etc.
(4) Beam limiting device : optical instruments, such as a camera, a video movie, and an endoscope.
(5) The mirror which can carry out adjustable.
<Pump> (6) ink-jet-printer (7) ion generator: The optical pickup, ultrasonic motor which are used for an air cleaner, a humidifier, and a dust catcher <motor> (8) piezo-electricity linear motor. <piezo-resonator> (9) oscillation element (10) discriminator (11) filter <sensor> (12) pressure-sensor (13) acceleration-sensor (14) shock sensor (15) acoustic-emission-sensor (Acoustic Emission) (16) supersonic-sensor (17) angular-velocity sensor (18) gravity sensor <mechanism-application> (19) micro relay (20 --) -- the actuator for bulb (22) hard disk drives (HDD) [0174] for super-thin film keyboard (21) fluid control
[Example] A concrete example explains this invention to a detail further below.
[0175] (Example 1) The variation rate of the slider from which the angle which the minute driver element of the lot of the actuator section and the field which met the disk side at the center line of the longitudinal direction of a perpendicular and a suspension make as the 1st experiment is changed and which a head element consists of was measured. Stainless thickness which is the base material of an actuator was set to 20 micrometers. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The result is shown in drawing 13 C. The rotational frequency of a disk was set to 1000rpm at this time.
[0176] Although most dependence according [ a variation rate ] to an angle in the time of a disk halt is not seen, at the time of disk rotation, it is less than 15 degrees and it turns out that it falls for the air viscous-friction force. When a variation rate and viscosity are taken into consideration from the above result, about 15 degrees or more are suitable for the angle of a driver element.
[0177] (Example 2) The substrate which gave etching processing beforehand to the actuator configuration for the stainless steel substrate was used for the actuator section.

[0178] After setting a processing substrate to a substrate electrode holder, it put in in the chamber of a sputtering system and was made the vacua (degree of vacuum : 2.0x10 -4 Pa). It checked that substrate temperature had become about 500 degrees C or more, and the platinum (Pt) which serves both as the thickness of 50nm and a lower electrode the titanium (Ti) which is the adhesion layer 9 was formed the thickness of about 50-200nm. Titanium (Ti) was used in order to raise the bond strength of a substrate and platinum (Pt). For this reason, you may form direct platinum (Pt) on a substrate without forming titanium (Ti), when the bond strength of a substrate and Pt layer is high. Next, PbLiTi of the ground layer which helps the crystal orientation of PbZrTiO3 of the lead-titanate system which is a piezo-electric thin film was formed the thickness of 10-50nm. Then, PbZrTiO3 of a piezo-electric thin film was formed the thickness of 2.5 micrometers. Au(gold) which is an up electrode was formed the thickness of 100-200nm after checking having become about 100 degrees C or less about substrate temperature.
[0179] Next, the substrate which formed membranes was taken out from the vacuum chamber, and the piezoelectric device was formed using lithography technology.
[0180] The resist for up electrode processing was applied to the beginning. the resist resin for processing -- the tradename made from SHIPUREI -- "S-1800" was used The stainless steel substrate which formed membranes was fixed to the glass substrate, and the resist was applied. The spinner method was used as the method of application. Then, after prebaking at 90 degrees C in oven for 15 minutes, it exposed by taking out. Exposure was performed using the photo mask, and it attached to the developer after exposure and negatives were developed. After development, oven performed the postbake at about 120 degrees C again for 30 minutes, and the etching-proof nature of a resist was raised. The resist was patternized at the above process and the up electrode was processed using the wet etching method. The etching reagent used the mixed liquor of potassium iodide (KI), iodine (I2), and water (H2O). After etching, with pure water, the substrate was washed and it dried. The thickness of a resist resin was about 1.0 micrometers. The processing state of an up electrode was checked with the optical microscope, and when satisfactory, the following piezo-electric thin film was processed.
[0181] Processing of a piezo-electric thin film is performed using buffered fluoric acid. Buffered fluoric acid was put into the beaker, and it warmed at about 60 degrees C, and was immersed the whole glass substrate for fixation into it. Buffered fluoric acid was always stirred so that concentration might become fixed. It washed and dried with pure water after etching. Next, the lower electrode was processed. The resist for an up electrode and piezo-electric thin film processing was removed, and the resist for lower electrode processing was applied again. The resist was exposed using the photo mask after an application. It turns around the pattern currently formed in the photo mask an up electrode and for piezo-electric thin film formation pattern twist 1, and the pattern of a big configuration and the drawer pattern of a lower electrode are formed. The lower electrode was processed using the dry etching method after exposure and development. The resist was removed and washed after dry etching. The resist was applied after washing. the tradename by Sumitomo Bakelite Co., Ltd. which is the positive-type photopolymer in which a resist resin contains polyimide resin here -- "CRC-8300" was used The method of application was performed using the spinner. The substrate was fixed to the flat thing of front faces, such as a glass substrate, like the time of etching. The polyimide was applied to the substrate, it was made to rotate by 3000rpm and the rotational frequency of a spinner was applied uniformly. At this time, the polyimide applied since it was close to the fixed substrate did not turn around the rear face (field which the piezoelectric device does not attach) of a substrate to a rear face. It patternized by performing exposure and development after the application. The patterns of a photo mask are a processing substrate and a somewhat larger pattern in the shape of isomorphism mostly. Next, BEKU in nitrogen-gas-atmosphere mind in order to stiffen a polyimide. BEKU was performed at 150-320 degrees C for 30 minutes using the oven which carried out the nitrogen purge. The thickness of polyimide resin was 2.0 micrometers.

[0182] After taking out from oven, removal of a processing substrate was performed. Removal of a processing substrate was sprayed in the shape of a spray to the substrate which removes a

ferric-chloride solution, and was performed.
[0183] It was able to imprint without using adhesives etc. for the polyimide which is synthetic resin from a stainless steel substrate by the above.
[0184] Next, in order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold.
[0185] The flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding after that. And the slider and the base plate were combined and the head support mechanism was constituted.
[0186] (Example 3) The substrate which gave etching processing beforehand to the actuator configuration for the stainless steel substrate was used for the actuator section.
[0187] For a lower electrode, a piezo-electric thin film, and membrane formation of an up electrode, the metal mask created by the stainless steel of about 0.1mm ** was beforehand set to the substrate, and membranes were formed. After setting a processing substrate and a metal mask to a substrate electrode holder, it put in in the chamber of a sputtering system and was made the vacua. It checked that substrate temperature had become about 500 degrees C or more, and the platinum (Pt) which serves both as the thickness of 50nm and a lower electrode the titanium (Ti) which is the adhesion layer 9 was formed the thickness of about 50-200nm. Titanium (Ti) was used in order to raise the bond strength of a substrate and platinum (Pt). For this reason, you may form direct platinum (Pt) on a substrate without forming titanium (Ti), when the bond strength of a substrate and Pt layer is high. Next, PbLiTi of the ground layer which helps the crystal orientation of PbZrTiO3 of the lead-titanate system which is a piezo-electric thin film was formed the thickness of 10-50nm. Then, PbZrTiO3 of a piezo-electric thin film was formed the thickness of 2.5 micrometers. Au(gold) which is an up electrode was formed the thickness of 100-200nm after checking having become about 100 degrees C or less about substrate temperature.
[0188] It became possible to exclude processing using the lithography technology of the piezoelectric-device section by the forming-membranes method using this metal mask. It checked that the temperature of a substrate had become ordinary temperature, and took out from the vacuum chamber, and the positive-type photopolymer containing the polyimide resin used in the example 2 was applied. The method of application was performed using the spinner. The substrate was fixed to the flat thing of front faces, such as a glass substrate, like the time of etching. The polyimide was applied to the substrate, it was made to rotate by 3000rpm and the rotational frequency of a spinner was applied uniformly. At this time, the polyimide applied since it was close to the fixed substrate did not turn around the rear face (field which the piezoelectric device does not attach) of a substrate to a rear face. It patternized by performing exposure and development after the application. The patterns of a photo mask are a processing substrate and a somewhat larger pattern in the shape of isomorphism mostly. Next, BEKU in nitrogen-gas-atmosphere mind in order to stiffen a polyimide. BEKU was performed at 150-320 degrees C for 30 minutes using the oven which carried out the nitrogen purge.
[0189] After taking out from oven, removal of a processing substrate was performed. Removal of a processing substrate was sprayed in the shape of a spray to the substrate which removes a ferric-chloride solution, and was performed. The thickness of polyimide resin was 2.0 micrometers.
[0190] It was able to imprint without using adhesives etc. for the polyimide which is synthetic resin from a stainless steel substrate by the above.
[0191] Next, in order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold. Then, the flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding.
[0192] And the slider and the base plate were combined and the head support mechanism was constituted.
[0193] In addition, although stainless steel was used as a substrate in this example of an experiment, forming similarly is possible even if it uses single crystal substrates, such as other metals, and MgO (magnesium oxide), Si (silicon).
[0194] (Example 4) The substrate which gave etching processing beforehand to the actuator

configuration for the stainless steel substrate was used for the actuator section. The manufacturing method which makes thickness of a processing substrate thin was used this time. Since it is the same as that of an example 2, the method of creating a piezoelectric device, the application of a polyimide, and an actuator configuration are omitted.
[0195] It is the difference in whether differing removes all stainless steel substrates or thickness is made thin.
[0196] After hardening the polyimide created in the actuator configuration, the secondary-salt-ized iron solution was sprayed in the shape of a spray. The stainless thickness which controls and removes this time to spray was controlled. After removing about 10 micrometers, it washed and dried with pure water. Next, in order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold. When the press was performed by having raised temperature to about 60-80 degrees C and having been taken out after cooling, it bent along with metal mold and structure has been formed.
[0197] Then, the flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding.
[0198] And the slider and the base plate were combined and the head support mechanism was constituted.
[0199] In addition, although stainless steel was used as a substrate in this experiment, forming similarly is possible even if it uses single crystal substrates, such as other metals, and MgO (magnesium oxide), Si (silicon).
[0200] (Example 5) The substrate which gave etching processing beforehand to the actuator configuration for the stainless steel substrate was used for the actuator section. The manufacturing method which removes a part of processing substrate was used this time. Since it is the same as that of an example 2, the method of creating a piezoelectric device, the application of a polyimide, and an actuator configuration are omitted.
[0201] After hardening the polyimide created in the actuator configuration, the polyimide was applied and patternized at the rear face of a substrate this time.
[0202] After carrying out heat hardening of the polyimide, the rear face of a substrate was turned up, it fixed to flat substrates, such as glass, and the polyimide was applied by the spinner. After the application, in order to remove excessive material, it prebaked in oven, and the photo mask was used and developed [ exposed and ]. Only the opposite side of a portion of the pattern after development in which the piezoelectric device is formed is in the state which the polyimide does not attach. After pattern formation, 150-320 degrees C and 30-minute temperature were raised in the oven in nitrogen-gas-atmosphere mind, and the polyimide was hardened in it.
[0203] Next, the stainless steel of the portion which is not covered by the polyimide was removed. The removal method sprayed the ferric-chloride solution in the shape of a spray, and **********ed. The structure which removed all the stainless steel of the portion which is not covered by the polyimide became possible by this method.
[0204] In addition, it is also possible to leave suitable thickness without removing all, since the thickness of the stainless steel of the portion which is not covered by the polyimide to remove is controllable in the concentration of an etching reagent, a blasting pressure, the amount of blasting, and time.
[0205] In order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold. Then, the flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding.
[0206] And the slider and the base plate were combined and the head support mechanism was constituted.
[0207] In addition, although stainless steel was used as a substrate in this experiment, forming similarly is possible even if it uses single crystal substrates, such as other metals, and MgO (magnesium oxide), Si (silicon).
[0208] (Example 6) The MgO single crystal substrate was used for membrane formation. After setting a substrate to a substrate electrode holder, it put in in the chamber of a sputtering system and was made the vacua. It checked that substrate temperature had become about 500 degrees C or more, and the platinum (Pt) which serves as a lower electrode was formed the

thickness of about 50-200nm. Next, PbLiTi of the ground layer which helps the crystal orientation of PbZrTiO3 of the lead-titanate system which is a piezo-electric thin film was formed the thickness of 10-50nm. Then, PbZrTiO3 of a piezo-electric thin film was formed the thickness of 2.5 micrometers. Au(gold) which is an up electrode was formed the thickness of 100-200nm after checking having become about 100 degrees C or less about substrate temperature.

[0209] Next, the substrate which formed membranes was taken out from the vacuum chamber, and the piezoelectric device was formed using lithography technology.

[0210] The resist resin used for the beginning in the example 2 for up electrode processing was applied. Next, the resist was applied to the substrate which formed membranes. The spinner method was used as the method of application. After prebaking at 90 degrees C in oven after that for 15 minutes, it exposed by taking out. Exposure was performed using the photo mask, and it attached to the developer after exposure and negatives were developed. Oven performed the postbake at about 120 degrees C again after development for 30 minutes, and the etching-proof nature of a resist was raised. It patternized in the above distance and the up electrode was processed using the wet etching method. The etching reagent used the mixed liquor of potassium iodide (KI), iodine (I2), and water (H2O). After etching, with pure water, the substrate was washed and it dried. The processing state of an up electrode was checked with the optical microscope, and when satisfactory, the following piezo-electric thin film was processed.

[0211] Processing of a piezo-electric thin film was performed using buffered fluoric acid. Buffered fluoric acid was put into the beaker, and it warmed at about 60 degrees C, and was immersed the whole glass substrate for fixation into it. Buffered fluoric acid was always stirred so that concentration might become fixed. It washed and dried with pure water after etching. Next, the lower electrode was processed. The resist for an up electrode and piezo-electric thin film processing was removed, and the resist for lower electrode processing was applied again. It exposed after applying a resist using the photo mask. It turns around the pattern currently formed in the photo mask an up electrode and for piezo-electric thin film formation pattern twist 1, and the pattern of a big configuration and the drawer pattern of a lower electrode are formed. The lower electrode was processed using the dry etching method after exposure and development. The resist was removed and washed after dry etching. The polyimide was applied after washing. Specifically, the method of application was performed using the spinner. The polyimide was applied to the substrate, it was made to rotate by 3000rpm and the rotational frequency of a spinner was applied uniformly. It patternized by performing exposure and development after the application. The patterns of a photo mask are a processing substrate and a somewhat larger pattern in the shape of isomorphism mostly. Next, BEKU in nitrogen-gas-atmosphere mind in order to stiffen a polyimide. BEKU was performed at 150-320 degrees C for 30 minutes using the oven which carried out the nitrogen purge.

[0212] After taking out from oven, all removal of a substrate was performed. All removal of a substrate was sprayed in the shape of a spray to the substrate which removes a phosphoric acid, and was performed.

[0213] It was able to imprint without using adhesives etc. for the polyimide which is synthetic resin from a substrate by the above.

[0214] Next, in order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold. Then, the flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding.

[0215] And the slider and the base plate were combined and the head support mechanism was constituted.

[0216] (Example 7) The MgO single crystal substrate was used for membrane formation. The manufacturing method which makes thickness of a substrate thin was used this time. Since it is the same as that of an example 6, the method of creating a piezoelectric device, the application of a polyimide, and an actuator configuration are omitted. It is the difference in whether differing removes all MgO substrates or thickness is made thin.

[0217] After hardening the polyimide created in the actuator configuration, the phosphoric-acid solution was sprayed in the shape of a spray. The thickness of MgO which controls and removes

this time to spray was controlled. After leaving about 10 micrometers and removing, it washed and dried with pure water. Next, in order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold. The press was performed by raising temperature to about 60-80 degrees C, after cooling, when taken out, it bent along with metal mold and structure has been formed.
[0218] Then, the flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding. And the slider and the base plate were combined and the head support mechanism was constituted. In addition, although MgO was used as a substrate in this experiment, forming similarly is possible even if it uses single crystal substrates, such as other metals and Si (silicon).
[0219] (Example 8) The MgO single crystal substrate was used for membrane formation. The manufacturing method which removes a part of substrate was used this time. Since it is the same as that of an example 6, the method of creating a piezoelectric device, the application of a polyimide, and an actuator configuration are omitted.
[0220] After hardening the polyimide created in the actuator configuration, the polyimide was applied and patternized at the rear face of a substrate this time.
[0221] After hardening a polyimide, the rear face of a substrate was turned up, it fixed to flat substrates, such as glass, and the polyimide was applied by the spinner. After the application, in order to remove excessive material, it prebaked in oven, and the photo mask was used and developed [ exposed and ]. Only the opposite side of a portion of the pattern after development in which the piezoelectric device is formed was in the state which the polyimide does not attach. After pattern formation, temperature was raised in the oven in nitrogen-gas-atmosphere mind for 150 degrees C - 320 or 30 minutes, and the polyimide was stiffened in it.
[0222] Next, MgO of the portion which is not covered by the polyimide was removed. The removal method sprayed the phosphoric-acid solution in the shape of a spray, and **********ed. The structure which removed all MgO(s) of the portion which is not covered by the polyimide became possible by this method.
[0223] In addition, it is also possible to leave suitable thickness without removing all, since the thickness which MgO of the portion which is not covered by the polyimide removes is controllable in the concentration of an etching reagent, a blasting pressure, the amount of blasting, and time.
[0224] In order to realize bending structure, the polyimide constituted by the actuator configuration was inserted in and pressed in metal mold. The flexible substrate and the minute driver-element section for wiring were electrically connected using wire bonding after that.
[0225] And the slider and the base plate were combined and the head support mechanism was constituted.
[0226] In addition, although MgO was used as a substrate in this experiment, forming similarly is possible even if it uses single crystal substrates, such as other metals and Si (silicon).
[0227] (Example 9) Stainless steel was processed in the shape of a cantilever, the electrode was formed on it with about 2.5-micrometer piezo-electric-crystal thin film on it, and the variation rate of the cantilever when changing stainless thickness by etching was measured. It is shown that the stainless substrate thickness of 0 micrometer is only a polyimide. The measuring method surveyed the variation rate using the laser-doppler method. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz.
[0228] The result is shown in following Table 1.
[0229]
[Table 1]

| ステンレスの厚み(μm) | 20 | 15 | 10 | 6 | 3 | 0 |
|---|---|---|---|---|---|---|
| 変位(μm) | 3.24 | 5.64 | 7.85 | 10.5 | 17.2 | 28.6 |

[0230] From the above result, the inclination for rigidity to become weak, so that the stainless thickness which is the base material of an actuator becomes thin, and for a variation rate to become large was seen.

[0231] Moreover, no matter what substrate it may use, as thickness of a substrate is made thin, it is clearer that it is possible for rigidity to fall and to obtain a variation rate greatly.
[0232] (Example 10) The variation rate was measured using the actuator produced by the process of an example 1. The stainless thickness which used the angle which the field in alignment with the center line of the longitudinal direction of a perpendicular and a suspension makes on a minute driver element and a disk as composition of a basic actuator 60 degrees, respectively set thickness of 2.5 micrometers and synthetic resin to 10 micrometers for the thickness of 20 micrometers and a piezo-electric thin film.
[0233] Composition is a type with which the minute driver element of the lot of the actuator section is arranged and which was altogether transposed to the synthetic resin shown in drawing 15 A-B. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The rotational frequency of a disk was set to 12000rpm at this time. For comparison, the actuator of the shape of isomorphism of the stainless steel base which does not use synthetic resin was also produced and measured. Compared with the object which is not transposed to synthetic resin, one about 4.4 times the variation rate of this was obtained by the result.
[0234] It has checked that a variation rate was sharply expandable by transposing to synthetic resin from stainless steel with this experiment.
[0235] (Example 11) The variation rate was measured using the actuator produced by the process of an example 3. The stainless thickness which used the angle which the field in alignment with the center line of the longitudinal direction of a perpendicular and a suspension makes on a minute driver element and a disk as composition of a basic actuator 60 degrees, respectively set thickness of 2.5 micrometers and synthetic resin to 10 micrometers for the thickness of 20 micrometers and a piezo-electric thin film.
[0236] Composition is the type transposed to the synthetic resin shown in drawing 16 A-B by which the minute driver element of the lot of the actuator section is arranged in part (configuration maintenance board portion of a piezoelectric device). Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The rotational frequency of a disk was set to 12000rpm at this time. For comparison, the actuator of the shape of isomorphism of the stainless steel base which does not use synthetic resin was also produced and measured. Compared with the object which is not transposed to synthetic resin, one about 4.5 times the variation rate of this was obtained by the result.
[0237] It has checked that a variation rate was sharply expandable by transposing a part to synthetic resin from stainless steel with this experiment.
[0238] (Example 12) The variation rate was measured using the actuator produced by the process of an example 4. The stainless thickness which used the angle which the field in alignment with the center line of the longitudinal direction of a perpendicular and a suspension makes on a minute driver element and a disk as composition of a basic actuator 60 degrees, respectively set thickness of 2.5 micrometers and synthetic resin to 5 micrometers for the thickness of 20 micrometers and a piezo-electric thin film.
[0239] Composition is a type with which the minute driver element of the lot of the actuator section is arranged and which covered by the synthetic resin shown in drawing 17 A-B, **********ed the whole, and made the stainless steel substrate thin. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The rotational frequency of a disk was set to 12000rpm at this time. For comparison, the actuator of the shape of isomorphism of the stainless steel base which does not use synthetic resin was also produced and measured. Compared with the object which is not transposed to synthetic resin, one about 3.1 times the variation rate of this was obtained by the result.
[0240] It has checked that a variation rate was sharply expandable by covering stainless steel by synthetic resin and making stainless thickness thin by this experiment.
[0241] (Example 13) The variation rate was measured using the actuator produced by the process of an example 4. The stainless thickness which used the angle which the field in

alignment with the center line of the longitudinal direction of a perpendicular and a suspension makes on a minute driver element and a disk as composition of a basic actuator 60 degrees, respectively set thickness of 2.5 micrometers and synthetic resin to 5 micrometers for the thickness of 20 micrometers and a piezo-electric thin film.
[0242] Composition is the type which covered by the synthetic resin shown in drawing 17 A-B by which the minute driver element of the lot of the actuator section is arranged, **********ed in part (configuration maintenance board portion of a piezoelectric device), and made the stainless steel substrate thin. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The rotational frequency of a disk was set to 12000rpm at this time. For comparison, the actuator of the shape of isomorphism of the stainless steel base which does not use synthetic resin was also produced and measured. Compared with the object which is not transposed to synthetic resin, one about 3 times the variation rate of this was obtained by the result.
[0243] It has checked that a variation rate was sharply expandable by covering stainless steel by synthetic resin and making thin a part of (configuration maintenance board portion of a piezoelectric device) stainless thickness by this experiment.
[0244] (Example 14) The variation rate was measured using the actuator produced by the process of an example 5. The substrate which used the angle which the field in alignment with the center line of the longitudinal direction of a perpendicular and a suspension makes on a minute driver element and a disk as composition of a basic actuator 60 degrees, respectively set thickness of 2.5 micrometers and synthetic resin to 10 micrometers for the thickness of a MgO single crystal substrate and a piezo-electric thin film.
[0245] Composition is a type altogether replaced by the synthetic resin shown in drawing 15 A-B by which the minute driver element of the lot of the actuator section is arranged. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The rotational frequency of a disk was set to 12000rpm at this time. For comparison, the actuator of the shape of isomorphism of the stainless steel base which does not use synthetic resin was also produced and measured. Compared with the object which is not transposed to synthetic resin, one about 8.1 times the variation rate of this was obtained by the result. The displacement expansion by transposing expansion of this variation rate to synthetic resin is as a result of the about 4 times and twice [ which grew epitaxially on the single crystal substrate / about ] as many synergistic effect as the improvement in a property of the piezoelectric constant d31 of a piezo-electric thin film.
[0246] It has checked that a variation rate was sharply expandable by replacing all by synthetic resin with this experiment.
[0247] (Example 15) The variation rate was measured using the actuator produced by the process of an example 5. The substrate which used the angle which the field in alignment with the center line of the longitudinal direction of a perpendicular and a suspension makes on a minute driver element and a disk as composition of a basic actuator 60 degrees, respectively set thickness of 2.5 micrometers and synthetic resin to 10 micrometers for the thickness of a MgO single crystal substrate and a piezo-electric thin film.
[0248] Composition is a type with which the minute driver element of the lot of the actuator section is arranged and which covers by the synthetic resin shown in drawing 16 , and replaces a part. Driver voltage was set it as **3V regularity, and frequency was set to 1kHz. Measurement surveyed the variation rate using the laser-doppler method. The rotational frequency of a disk was set to 12000rpm at this time. For comparison, the actuator of the shape of isomorphism of the stainless steel base which does not use synthetic resin was also produced and measured. Compared with the object which is not transposed to synthetic resin, one about 7.8 times the variation rate of this was obtained by the result. The displacement expansion by transposing expansion of this variation rate to synthetic resin is as a result of the about 4 times and twice [ which grew epitaxially on the single crystal substrate / about ] as many synergistic effect as the improvement in a property of the piezoelectric constant d31 of a piezo-electric thin film.
[0249] It has checked that a variation rate was sharply expandable to synthetic resin by replacing a part from MgO with this experiment.

[0250] (Example 16) The wiring structure shown by drawing 22 A1 and A2 was created, and before [ which used the pressing method ] processing it by bending, after carrying out, it examined how the electric property of a piezoelectric device would change. The composition of a piezoelectric device is Ti/Pt/PLT/PZT/Pt. The piezoelectric device formed membranes on stainless steel. Processing of a piezoelectric device was made unnecessary at membrane formation using the metal mask. The lower electrode was taken from stainless steel and patternized [ the up electrode ] the polyimide of a cover layer for copper wiring formation and after that with plating, using a polyimide as a base insulating layer. Measurement measured L (inductance), C (capacitance), and Z (impedance) on the frequency of 1kHz using the LCR meter. A result is shown in following Table 2.

[0251]

[Table 2]

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0．627Mオーム | 0．628Mオーム |
| L (インダクタンス) | −99．8H | −99．9H |
| C (キャパシタンス) | 0．2543nF | 0．2535nF |

[0252] From the above result, after bending was bent, the same electrical property as a front was acquired, and it has checked that three dimensions solid wiring structure was possible.

[0253] (Example 17) The wiring structure shown by drawing 22 B1 and B−2 was created, and before [ which used the pressing method ] processing it by bending, after carrying out, it examined how the electric property of a piezoelectric device would change. The composition of a piezoelectric device is Ti/Pt/PLT/PZT/Pt. The piezoelectric device formed membranes on stainless steel. Processing of a piezoelectric device was made unnecessary at membrane formation using the metal mask. The lower electrode was taken from stainless steel and patternized [ the up electrode ] the polyimide of a cover layer for copper wiring formation and after that with plating, using a polyimide as a base insulating layer. It bent at the end and etching removal of the stainless steel of a portion was carried out with the ferric−chloride solution. Measurement measured L (inductance), C (capacitance), and Z (impedance) on the frequency of 1kHz using the LCR meter. A result is shown in following Table 3.

[0254]

[Table 3]

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0．611Mオーム | 0．620Mオーム |
| L (インダクタンス) | −98．8H | −97．9H |
| C (キャパシタンス) | 0．2533nF | 0．2545nF |

[0255] From the above result, after bending was bent, the same electrical property as a front was acquired, and it has checked that three dimensions solid wiring structure was possible. Moreover, the good result was obtained, when the stainless bending portion which is a substrate was removed, although it was some when the yield after bending was compared.

[0256] (Example 18) The wiring structure shown by drawing 22 C1 and C2 was created, and before [ which used the pressing method ] processing it by bending, after carrying out, it examined how the electric property of a piezoelectric device would change. The composition of a piezoelectric device is Ti/Pt/PLT/PZT/Pt. The piezoelectric device formed membranes on stainless steel. Processing of a piezoelectric device was made unnecessary at membrane formation using the metal mask. The lower electrode was taken from stainless steel and patternized [ the up electrode ] the polyimide of a cover layer for copper wiring formation and after that with plating, using a polyimide as a base insulating layer. Measurement measured L (inductance), C (capacitance), and Z (impedance) on the frequency of 1kHz using the LCR meter. A result is shown in following Table 4.

[0257]

[Table 4]

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0. 612Mオーム | 0. 635Mオーム |
| L (インダクタンス) | −97. 8H | −97. 9H |
| C (キャパシタンス) | 0. 2543nF | 0. 2575nF |

[0258] From the above result, after bending was bent, the same electrical property as a front was acquired, and it has checked that three dimensions solid wiring structure was possible.
[0259] (Example 19) The wiring structure shown by drawing 22 D1 and D2 was created, and before [ which used the pressing method ] processing it by bending, after carrying out, it examined how the electric property of a piezoelectric device would change. The composition of a piezoelectric device is Ti/Pt/PLT/PZT/Pt. The piezoelectric device formed membranes on stainless steel. Processing of a piezoelectric device was made unnecessary at membrane formation using the metal mask. The lower electrode was taken from stainless steel and patternized [ the up electrode ] the polyimide of a cover layer for copper wiring formation and after that with plating, using a polyimide as a base insulating layer. It bent at the end and etching removal of the stainless steel of a portion was carried out with the ferric-chloride solution. Measurement measured L (inductance), C (capacitance), and Z (impedance) on the frequency of 1kHz using the LCR meter. A result is shown in following Table 5.
[0260]
[Table 5]

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0. 632Mオーム | 0. 655Mオーム |
| L (インダクタンス) | −99. 9H | −98. 9H |
| C (キャパシタンス) | 0. 2553nF | 0. 2585nF |

[0261] From the above result, after bending was bent, the same electrical property as a front was acquired, and it has checked that three dimensions solid wiring structure was possible. Moreover, the good result was obtained, when the stainless bending portion which is a substrate was removed, although it was some when the yield after bending was compared.
[0262] (Example 20) The wiring structure shown by drawing 23 A1, B1, C1, and D1 was created, and before [ which used the pressing method ] processing it by bending, after carrying out, it examined how the electric property of a piezoelectric device would change. The composition of a piezoelectric device is Ti/Pt/PLT/PZT/Pt. The piezoelectric device formed membranes on stainless steel. Processing of a piezoelectric device was made unnecessary at membrane formation using the metal mask. On stainless steel, the polyimide was formed as an insulating layer, the polyimide of a cover layer was patternized [ the lower electrode and the up electrode ] for copper wiring formation and after that with plating, using a polyimide as a base insulating layer, and each electrode was taken out to the up electrode side. Bending processing by the pressing method created what carried out etching removal of the stainless steel of a bending portion with the ferric-chloride solution, and the thing without that right. Measurement measured L (inductance), C (capacitance), and Z (impedance) on the frequency of 1kHz using the LCR meter. A result is shown in following Tables 6-9.
[0263]
[Table 6]

(a−1)

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0. 732Mオーム | 0. 745Mオーム |
| L (インダクタンス) | −100. 9H | −100. 9H |
| C (キャパシタンス) | 0. 2543nF | 0. 2575nF |

[0264]
[Table 7]

(b－1)

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0. 722Mオーム | 0. 715Mオーム |
| L (インダクタンス) | －99. 9H | －99. 9H |
| C (キャパシタンス) | 0. 2523nF | 0. 2515nF |

[0265]
[Table 8]

(c－1)

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0. 752Mオーム | 0. 733Mオーム |
| L (インダクタンス) | －99. 5H | －98. 9H |
| C (キャパシタンス) | 0. 2574nF | 0. 2565nF |

[0266]
[Table 9]

(d－1)

| | 折り曲げ前 | 折り曲げ後 |
|---|---|---|
| Z (インピーダンス) | 0. 745Mオーム | 0. 744Mオーム |
| L (インダクタンス) | －100. 9H | －99. 9H |
| C (キャパシタンス) | 0. 2573nF | 0. 2575nF |

[0267] The good result that an electrical property hardly changed from the above result before and after bending processing by the pressing method in the structure shown in drawing 23 A1 - drawing 23 D1 was obtained. Therefore, by using the wiring structure by synthetic resin, three dimensions solid wiring structure is realizable.
[0268]
[Effect of the Invention] According to this invention, a piezoelectric device can be element-ized, without using adhesives, and detailed-izing of an element and a free design are still more possible. moreover, as compared with the conventional piezoelectric device, it can be markedly alike, and a variation rate can be obtained When it applies as actuators, such as the magnetic head, especially, a controllable actuator and a controllable information record regenerative apparatus can be realized with high precision. Moreover, although a miniaturization is needed when [ that resonance frequency is low ] high-speed control is difficult, even if it miniaturizes, displacement/voltage (efficiency) can be taken out efficiently. Moreover, it is possible to also lower power consumption by thin-film-izing.

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[Translation done.]

* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1 A] A-D is cross-section explanatory drawing showing the fundamental composition of the actuator mechanism of the gestalt 1 of operation of this invention.
[Drawing 1 B] E-G is cross-section explanatory drawing showing the fundamental composition of the actuator mechanism of the gestalt 1 of operation of this invention.
[Drawing 2] A-C is cross-section explanatory drawing showing operation of the actuator of the gestalt 1 of operation of this invention.
[Drawing 3] A-F is cross-section explanatory drawing in which showing the method of forming the piezoelectric device in the case of having no metal mask of the gestalt 2 of operation of this invention, and showing the method of forming membranes in with this metal mask in G-L.
[Drawing 4] A-F is cross-section explanatory drawing in which showing the manufacturing method of the actuator in the case of having no metal mask of the gestalt 2 of operation of this invention, and showing the manufacturing method in with this metal mask in G-I.
[Drawing 5] A-F is cross-section explanatory drawing in which showing the manufacturing method of the actuator in the case of having no metal mask of the gestalt 2 of operation of this invention, and showing the manufacturing method in with this metal mask in G-I.
[Drawing 6] A-D is cross-section explanatory drawing in which showing the manufacturing method of the actuator in the case of having no metal mask of the gestalt 2 of operation of this invention, and showing the manufacturing method in with this metal mask in E-G.
[Drawing 7] A-D is cross-section explanatory drawing in which showing the manufacturing method of the actuator in the case of having no metal mask of the gestalt 2 of operation of this invention, and showing the manufacturing method in with this metal mask in E-G.
[Drawing 8] A-F is cross-section explanatory drawing in which showing the manufacturing method of the actuator in the case of having no metal mask of the gestalt 2 of operation of this invention, and showing the manufacturing method in with this metal mask in G-J.
[Drawing 9] A-E is cross-section explanatory drawing showing the manufacturing method of the actuator when not using the processing substrate of the gestalt 2 of operation of this invention.
[Drawing 10] A-D is cross-section explanatory drawing showing the manufacturing method of the actuator when not using the processing substrate of the gestalt 2 of operation of this invention.
[Drawing 11] A-E is cross-section explanatory drawing showing the manufacturing method of the actuator when not using the processing substrate of the gestalt 2 of operation of this invention.
[Drawing 12] The assembly view showing the fundamental composition of the actuator mechanism of the gestalt 3 of operation of this invention.
[Drawing 13] It is drawing showing the angle at which A is the cross section showing the physical relationship of the driver element of the actuator section of the gestalt 3 of operation of this invention, and a disk side, and a field perpendicular to the driver element of this actuator section and a disk side accomplishes B. C is drawing showing the measurement data of the variation rate of the actuator of the example 1 of this invention.
[Drawing 14] A-B is drawing showing operation of the actuator of the gestalt 3 of operation of this invention.

[Drawing 15] A is a block diagram at the time of applying the actuator of the gestalt 3 of operation of this invention to a hard disk, and B is the elements on larger scale of the round-head portion of A.
[Drawing 16] A is a block diagram at the time of applying the actuator of the gestalt 3 of operation of this invention to a hard disk, and B is the elements on larger scale of the round-head portion of A.
[Drawing 17] A is a block diagram at the time of applying the actuator of the gestalt 3 of operation of this invention to a hard disk, and B is the elements on larger scale of the round-head portion of A.
[Drawing 18] Explanatory drawing at the time of putting a restricted relief means into the actuator of the gestalt 3 of operation of this invention.
[Drawing 19] Explanatory drawing showing the composition at the time of preparing the supporting point in the actuator of the gestalt 3 of operation of this invention.
[Drawing 20] The perspective diagram showing the composition of the actuator of the gestalt 4 of operation of this invention.
[Drawing 21] A-D is explanatory drawing showing operation of the actuator of the gestalt 4 of operation of this invention.
[Drawing 22] A1, B1, C1, and D1 are the perspective diagrams showing the wiring structure of the piezo-electric formula actuator of the gestalt 5 of operation of this invention, and A2, B-2, and C2 and D2 are this cross section.
[Drawing 23] A1, B1, C1, and D1 are the perspective diagrams showing the wiring structure of the piezo-electric formula actuator of the example 20 of this invention, and A2, B-2, and C2 and D2 are this cross section.
[Drawing 24] Explanatory drawing showing the conventional actuator.
[Description of Notations]
1 Piezo-electric Thin Film
2a Lower electrode
2b Up electrode
3 Piezoelectric Device
4 12 Synthetic resin
5 Fixed Part
6 Outgoing Line
7 Through Hole
8 Object to Operate
9 Titanium (Ti)
10 Ground Layer (PLT)
11 Metal Mask
13 Head Element
14 Slider
15 25 Suspension
16 Base Plate
17 Supporting Point
18 Driver Element (Minute Driver Element)
19 Disk Side
20 Restricted Relief Means
21 Field Perpendicular to Disk Side
22 Mounting Section
23 Planar Type Piezo-electric Element
24 Hinge
40 Substrate

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[Translation done.]